POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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WE DO OUR PART

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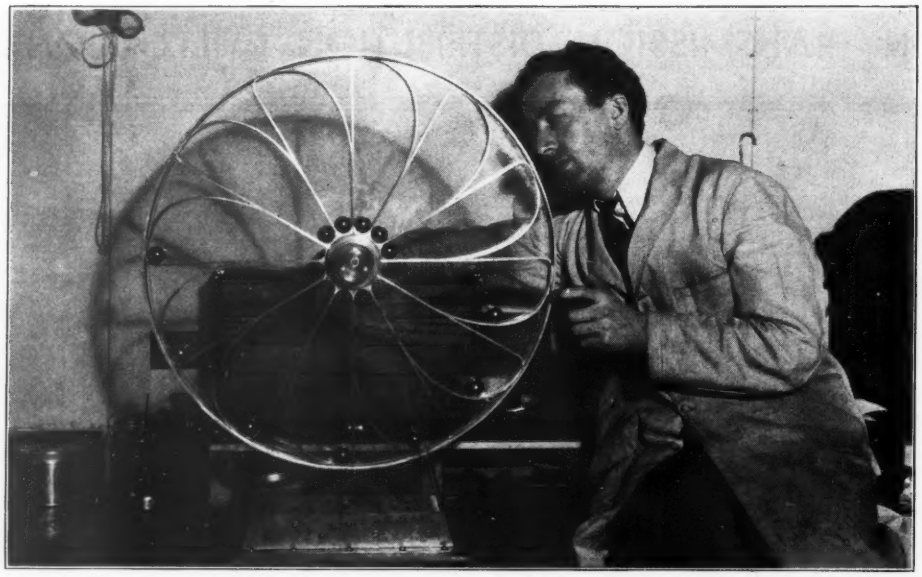
They Keep on Making 'em



DOWN THROUGH HISTORY, ever since the idea of the wheel was evolved, no doubt, men have dreamed of perpetual motion machines. Hundreds of thousands of inventors have struggled with the idea and today thousands are still struggling with it. Alluring, evanescent, tantalizing, it has resisted all discouragement—the most intriguing will-o'-the-wisp in the history of science, at once the symbol of man's inherent laziness and his ceaseless ambition.

Here, for example, you see an exact model of a perpetual motion machine devised by the Marquis of Worcester in the 17th Century. The Marquis, a sly old bird, mind you, planned to operate it with rolling balls, contending that, on the principle of the lever, a ball distant from the center would raise a ball nearer to the center of the wheel. This was a clever idea, to say the least, and in its day created a lot of attention; indeed, there was only one thing wrong with it—it wouldn't work; nor would any other machine of this character, but that never discouraged the inventors. The second law of thermodynamics meant nothing to them and even if it had they would have kept right on. They do to this day, despite the second law of thermodynamics. The one thing "perpetual" about these devices is the perpetual enthusiasm of these ingenious but simple minded souls who never give up. No search for a pot of gold at the foot of the rainbow could be more futile than their's.

The machine shown above is one of several models of perpetual motion machines to be included in the mathematical exhibit at the Century of Progress Exposition in Chicago this summer. It is probably not with any serious idea of discouraging inventors that these models are exhibited but they will be of interest to the public and demonstrate conclusively the fallacy of the idea. As explained in an article on the 1934 Century of Progress Exposition in this issue, special methods will be used to show why these machines won't work.

* *

One of the greatest problems in this world is to find money for buying the things we want. Various methods for solving this problem are in vogue. Bank robbers and hijackers have one way, bankers and politicians another, both highly effective at times, but most of us, because of circumstance, virtue, or lack of courage, are compelled to use more conservative methods.

For worthy business purposes (and worthy here implies profitable) in the past, the banker furnished the money, but since things have not been so rosy for the bankers, other methods of financing have been developed. In the automobile business, for example, if you want to buy a car and haven't the cash in hand, a special "outside" financing company set up for the purpose advances the money and you get your car.

In the power industry, for the most part, financing purchases of new equipment has been accomplished by the time-honored banker method but other, newer methods have also been employed at various times. It is for the purpose of describing what has been done in this direction that we are presenting in this issue an article on methods of financing plant improvements. At a time when business is improving and when plant additions are in order, we feel that an article on this subject should be of interest.

* * *

Often a more difficult problem than the financing of new equipment is the selection of the proper equipment for economy. This question divides itself into two parts, first, the problem of selecting equipment to replace existing equipment which has become obsolete, and second, that of selecting equipment to provide either additional capacity or a new service of a kind conducive to economy. These two aspects of this problem will be presented in two articles by Linn Helander, the first of which appears on page 270.

WITH THE EDITORS

New Equipment in the Power Field

THAT FUNDAMENTAL scientific principles are being employed more and more in the development and improvement of manufactured power plant equipment will be evident to anybody who has been keeping posted on this phase of power plant practice. Particularly popular at the present time are the developments of the principles of electrical physics into commercial applications. Many of these developments are the direct offspring of the principles employed in radio engineering and have been accepted by operators after demonstration without a clear understanding of the underlying principles.

Much was accomplished last year at A Century of Progress Exposition in acquainting the general public with the principles of the sciences used in industry and it is quite likely that some of the new applications which are appearing in manufactured equipment have been stimulated, if not originated, by what was on exhibit last year. Whatever may have been the cause, the change in the type of development is quite evident.

In many respects, the success of these new tools of the power plant depends upon the engineers in charge of their care and operation. Business competition will demand the use of much of this new equipment in new and modernized power plants and engineers will be compelled to look after it, so it behooves every engineer to acquaint himself first with the fundamental principles of all new equipment coming into the field, then the details of construction of the various devices and equipment applicable to the plant in which he is employed.

Better Operation

STEAM FROM the industrial power engineer's standpoint serves two purposes, it supplies heat for process work and it generates electrical or mechanical power. Taken alone, either use means a loss, the first through sacrifice of the potential power represented by the heat head, the second through the heat rejected by the prime mover. The function of the engineer is to combine these two uses so that the losses are minimized.

This can be done by using the heat rejected by the prime mover for process or building heating, but unfortunately the actual problem is not as simple as it sounds on paper. Not only are operating conditions variable but the losses themselves are difficult to evaluate, making it impossible to say just how much money can be economically spent to reduce them. Under these conditions it is but natural that many general and partial solutions of the problem are available for guidance of those interested.

When electric power is the primary object, heat is rejected by the prime mover as exhaust at a temperature of around 80 deg. F. This is too low for use in heating or process work so that any utilization of this rejected heat means increasing the back pressure, with a corresponding reduction in the amount of power available from a given amount of steam. This can be compensated for by increasing the initial steam pressure and temperature.

If heat is the primary object, steam is usually generated at 75 to 125 lb. pressure and throttled through a reducing valve to the desired process pressure. This throttling represents a loss of heat head or potential power which is extremely valuable. If the prime mover receives credit for the exhaust, power can be generated at a thermal efficiency of well over 90 per cent or about four times that possible under condensing operation. The greater the throttling range the greater the power possibilities.

Theoretically the solution of the problem is simple—increase the initial pressure and temperature until the steam needed for power will give just sufficient power to take care of the load. Unfortunately the steam and power loads seldom coincide so that only partial solutions of the problem are possible. Back pressure and condensing operation, extraction turbines, mixed pressure turbines, purchased power and power exchange agreements represent the results of years of effort to take care of these unbalanced load conditions.

It is obvious that yearly, monthly, weekly or even daily averages are of little use in this connection. Hour by hour load records are necessary. Backed by records of past operation, the engineer is not only able to suggest load changes or a different sequence of operation to better operation but is in a position to recommend changes in and predict the performance of new equipment. Instruments and their records form an item of plant operation that should never be neglected.

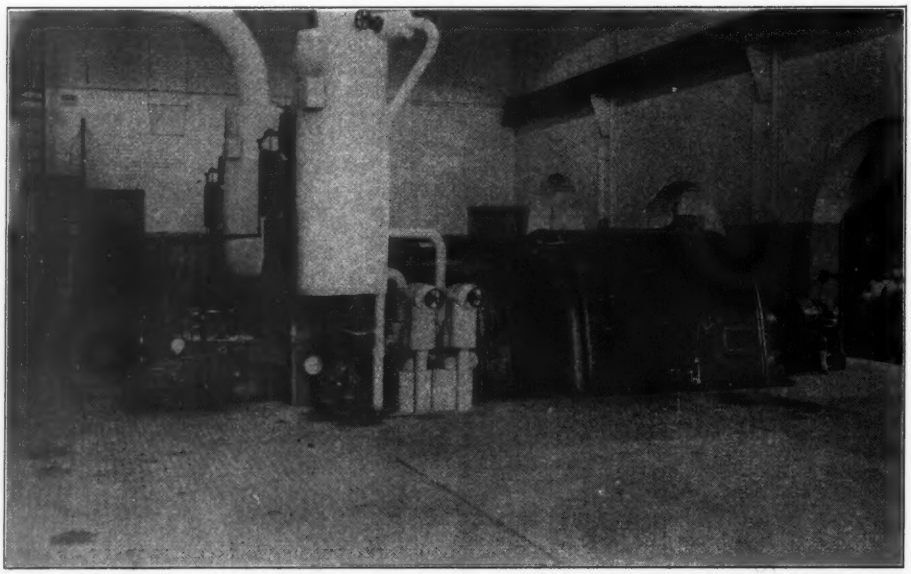
Air Conditioning

DURING THE PAST few years the practical application of air conditioning has done much to alleviate the suffering caused by hot weather. From an engineering standpoint there is no reason why cooling in summer should not be as common and successful as heating in winter, nor is there any reason why suitable humidity and dust control should be neglected in either process.

Theatres were pioneers in this field and must be given credit for breaking down this condition of passive suffering, although hotels and restaurants have also played an important part. Office buildings are now taking an active interest and it is probable that, in the cities at least, all future public buildings will have provision for air conditioning throughout the year.

Why this development did not take place earlier is difficult to answer. The practical application of refrigeration to this particular field has engaged the attention of scores of manufacturers and equipment from small portable, or semi-portable, units of about 1 t. capacity up to large central systems of several hundred tons capacity are available. No longer need air conditioning in summer be confined to industrial processes where it is necessary regardless of expense. Air conditioning has the same range of application and is as necessary as heating to the comfort and welfare of the general public.

High Back Pressure Turbines *for*



Two 700 lb. High Back Pressure Turbines driving 2400 v. alternators at the new Bayonne Plant

OIL REFINING IS A COMPLEX process. A complete oil refinery, that is one in which crude petroleum is refined down to all of its valuable derivatives, probably ranks foremost among the industries in the wide diversification of machinery and equipment used to carry on its manifold processes and operations, nearly all of which are continuous.

Aside from the complexity of the purely chemical processes involved in the refining of petroleum, the power requirements and the means for satisfying these requirements introduce additional complexity. No one who has ever visited a large refinery can fail to have experienced amazement and bewilderment at the multitudinous overhead and underground pipe lines, pumping stations, etc., and the maze of electric power lines which dominate the landscape in every direction. The power demands of a modern refinery are large and many, they include the pumping of huge quantities of salt water and fresh water for condensing purposes, fire protection and steam generation, electricity for power drives, refrigeration and lighting, steam for processing, heating, drying, agitation and pumping, and finally compressed air for lifting and the operation of mechanical tools of various description.

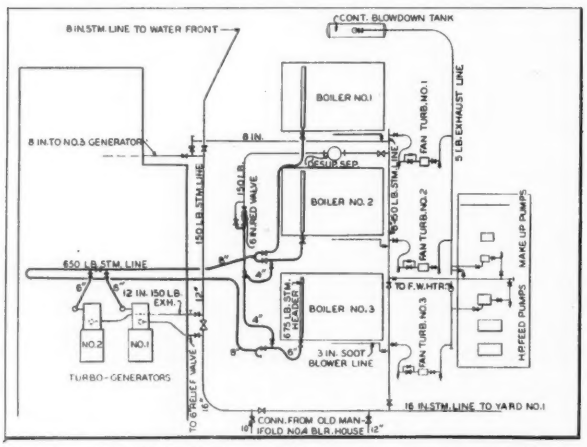


FIG. 1. DIAGRAMMATIC LAYOUT OF HIGH PRESSURE STEAM AND EXHAUST LINES IN NEW POWER PLANT

To fuse the wide variety of uses of these utilities into a workable and efficient operating unit requires not only a study of each phase of the various processing functions, but more especially a close study of modern scientific development in the refining of petroleum. Research work has revolutionized these processes within the last ten years and today development continues at an increasing rate, constantly improving the quality of the marketable products.

Because of this rapid development in the refining processes, the power requirements also change, usually long before the conservative life of the machinery involved has been realized. This is particularly true with regard to the electrical load. The strong aversion toward comprehensive electrification in the oil refinery of ten years ago, due to the fire hazard which electrical equipment imposed, has almost entirely disappeared with the development of improved fire and explosion proof motors and control equipment. As a consequence we find today that the electrical load of the modern refinery represents an appreciable portion of its total power requirements. This load also has the valuable characteristic of being comparatively free from wide load fluctuations excepting those fluctuations, of course, due to momentary motor starting characteristics.

furnish By-Product Power Tide Water Oil Refinery *at* Bayonne

By E. A. BAERER

Superintendent of Power
Bayonne (N. J.) Refinery,
Tide Water Oil Company

Coincident with the progress made in methods of refinery during the past ten or fifteen years, we find similar progress in the realm of industrial steam and power production, particularly as regards the use of high pressures and temperatures. The favorable economic possibilities in the use of steam at high pressures and temperatures for by-product electric power generation has made the refinery power plant of yesterday obsolete today. While the mixed-pressure and extraction types of turbo-generators lend themselves admirably to oil refinery, power demands, the more recent improvements in high pressure steam generation, particularly chemical water conditioning and high initial steam pressures, has brought the high back pressure turbo-generator forcibly to the foreground as a medium of power cost reduction of the first magnitude. Due principally to its extreme simplicity, absence of condensing equipment and comparatively low water rate, it is truly a high quality reducing valve.

Chemical water conditioning at high initial steam pressures is mentioned here because it is an important factor in the operation of noncondensing prime movers. This is particularly important in a refinery because in this type of industrial plant the amount of make up water for steam generation is rarely under 85 per cent.

With a full understanding of the underlying problems involved and the economic possibilities, coupled with adequate records of the uses of all of its utilities (steam, water, compressed air and electricity) the Power Engineering Department of the Tide Water Oil Co. on February 16, 1933, started construction of a complete 700 lb. pressure steam electric generating plant at the Bayonne, New Jersey, refinery. This plant is of interest not only because of the decided increase in pressure used but also because of its many novel constructional features.

This new plant was erected adjacent to an existing 150 lb. steam electric generating plant using one 3750-kv-a. mixed pressure and one 3750 kv-a. straight condensing turbo-generator. The boiler house serving this plant also was connected, by means of a 10 in. main, to two other 150 lb. steam generating plants located in strategic positions with respect to the refinery load. The refinery by the way covers approximately 180 acres of ground.

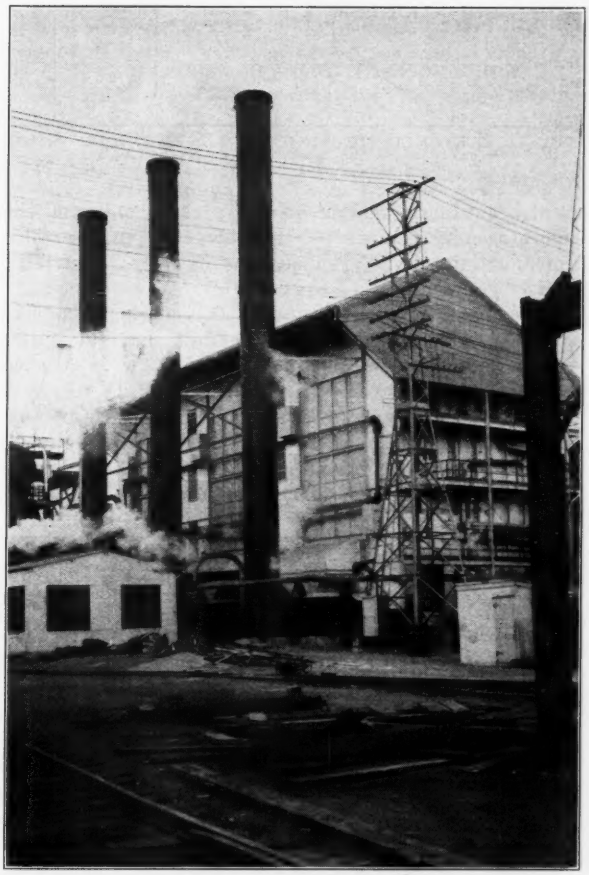


Fig. 2. View of the New Boiler Plant

A schematic diagram of the arrangement existing before the new plant was built is shown in Fig. 3A, while in Fig. 3B is shown the arrangement prevailing today, that is, after the installation of the 700 lb. plant. The new plant was started on November 6, 1933.

The physical arrangement of this new plant was determined largely by the existing building arrangement. One of the old 3375-kw. generating units was retained. The other, No. 4 as indicated on the diagram Fig. 3A, was removed to make room for the two new high pressure units. The old boiler house was entirely abandoned and the new units were erected on an unoccupied plot of ground immediately adjacent thus making it possible to operate the old units until the new ones were finished. The new boilers are set prac-

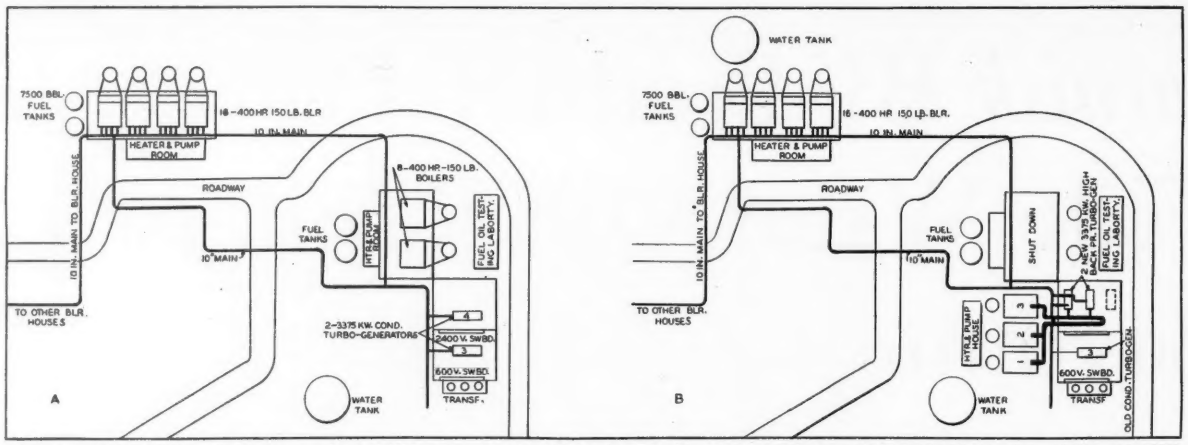


FIG. 3. SKETCHES SHOWING ARRANGEMENT OF PLANTS BEFORE AND AFTER CONSTRUCTION OF NEW PLANT. A. BEFORE NEW PLANT WAS BUILT. B. AFTER NEW PLANT WAS BUILT

tically outdoors, shelter being provided only for the operators, instrument panels and feed pumps. This construction, though unusual, is entirely practicable and of course involves considerably less investment.

Among the novel features of this plant, the one of greatest interest perhaps is the fact that the entire refinery electric load amounting to 4500 kw. is satisfied by by-product power, the turbine receiving steam at 700 lb. pressure and at 750 deg. temperature and exhausting at 150 lb. pressure directly into the main 150 lb. refinery steam mains. Control of the boilers is manual except of course that the feed to the boilers is controlled automatically by means of feedwater regulators.

Another unusual feature of this plant is the arrangement of the forced and induced draft fans. Each boiler has its individual forced and induced draft fan and stack. The two fans are installed on the grade level immediately in front of the boilers, the forced draft fans being located inside the protective housing for the operators while the induced draft fans are located outside. The two fans for each boiler are belted together and driven from a common turbine through reduction gears. The belts of course pass through

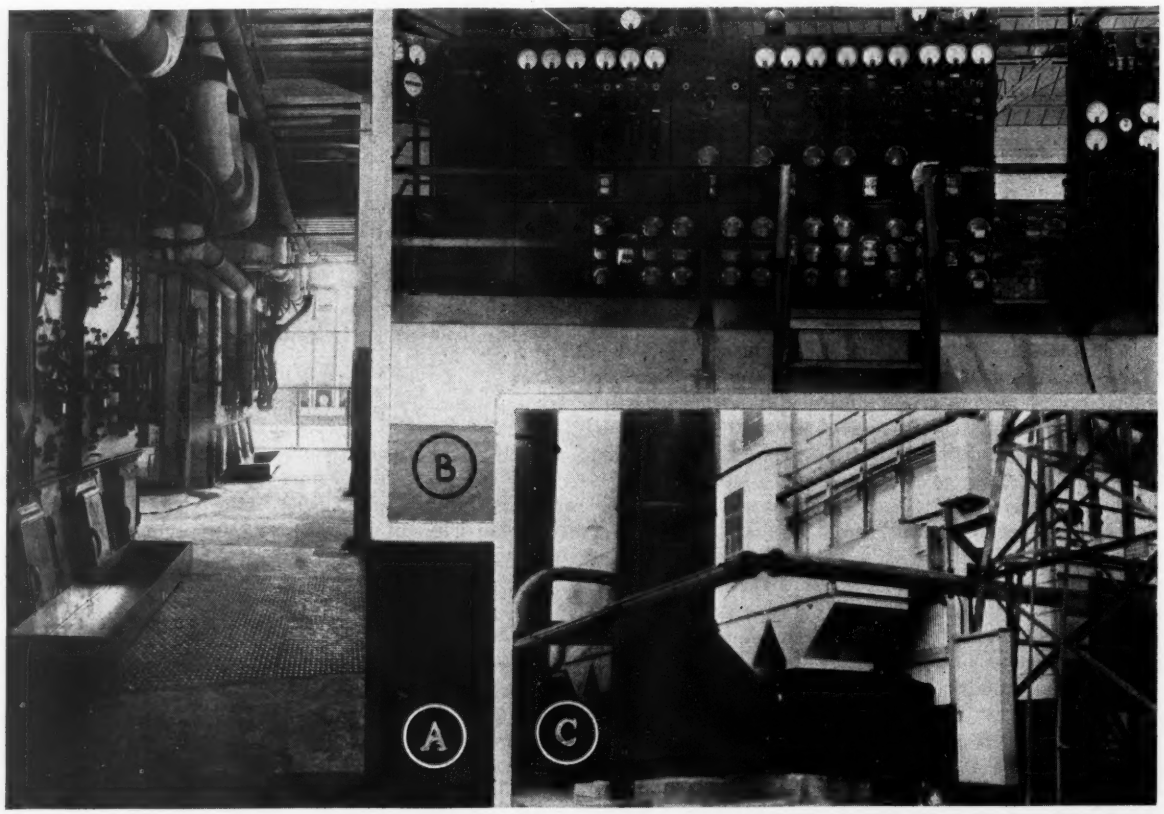


FIG. 4. VIEW OF THE NEW PLANT AT THE TIDE WATER REFINERY. A. LOOKING ALONG THE BOILER FRONT, SHOWING OIL BURNERS. B. THE 2400 V. SWITCHBOARD. THE PANEL FOR THE TWO NEW GENERATORS IS AT THE EXTREME RIGHT. C. A VIEW SHOWING THE FORCED DRAFT FANS AND THE BASE OF THE STACKS.

Principal Equipment Installed at the Tide Water Plant

Boilers—3, steel jacketed Stirling 6 drum (integral economizer) with superheater and bare water walls, 713 lb. pressure, 250 deg. superheat, all welded drums, furnished by Babcock & Wilcox Co.
Furnace—American Arch Co.
Burners—6, mechanical atomizing burners per boiler furnace, San Diego type, 10-16 gravity, 250 deg., Babcock & Wilcox Co.
Safety Valves—5 per boiler, furnished by Consolidated Ashcroft Hancock Co.
Water Columns—Diamond Power Specialty Corp.
Blow-down Valves—Cochrane Corp., tandem, 1½ in. valves, 5 valves per boiler.
Stop and Check Valves—Crane Co.
Soot Blowers—Diamond Power Specialty Corp., valve-in-head, 10 per boiler.
Instruments—Bailey Meter Co. and Foxboro Co.—flow meter, recording temperature gages and panels.
Boiler Water Level Control—Stets Co.
Boiler Water Conditioning System—Hall Laboratories, Inc.
Fuel Oil Pumps—National Transit Co., 3—7½x4x12 in. Duplex rec. pumps.
Feedwater Heater—Elliott Co. deaerating heater with 5 minute storage supply tank, 450,000 lb. per hr. capacity.
Feedwater Heater Pumps—2, 700 g.p.m., 3550 r.p.m., 125 ft. head, Ingersoll-Rand Co. centrifugal pumps driven by 40 hp. Allis-Chalmers motor and De Laval turbine, 3550 r.p.m., 150 lb. steam pressure, 5 lb. exhaust pressure.
Boiler Feed Pumps—3, 562 g.p.m., 3550 r.p.m., 1900 ft. head Ingersoll-Rand centrifugal pumps, 1 driven by 700 hp. De Laval turbine and 2 driven by Allis-Chalmers 2200 v., 500 hp., 3 ph., 60 cycle induction motors.
Fans—Each boiler equipped with one 37,000 c.f.m. forced draft and one 74,000 c.f.m. induced draft. B. F. Sturtevant Co. Multi and Turbovane fans belted and coupled to a 200-hp. De Laval turbo-helical reduction gears have a ratio of 3:48.
Chimney—Each boiler equipped with one 6 by 12 ft. steel stack furnished by Bergen Point Iron Works.
Valves—All steel high pressure valves and piping furnished by Crane Co. with Mid-West flanged and all welded joints.
Traps—High pressure all steel Strong, Carlisle & Hammond Co.
Turbines—2, 3375 kw., 3 ph., 2400 v., 60 cycle, a.c. turbo-generator sets—8 stage 650 lb., 150 lb. back pressure turbines furnished by General Electric Co.
Exciters—Shaft exciters 150 volt, 100 amp., 15 kw. General Electric Co.
Switchboard—Westinghouse Elec. & Mfg. Co. remote control.
Instruments—Westinghouse Elec. & Mfg. Co. complete.
Circuit Breakers, Relay, etc.—Westinghouse Elec. & Mfg. Co. complete.
Voltage Regulators—Westinghouse Elec. & Mfg. Co. wide range regulator.
Fuel Oil Heaters—Foster Wheeler Corp.

suitable openings in the walls of the protective housing. The pulleys are designed so that a constant speed ratio between the two fans is maintained at all times.

The feedwater heaters and pumps as well as the recording instruments are located in a small building opposite the boilers.

Extreme simplicity was followed in the entire design resulting in lower construction costs. It was felt that trends in the refining industry would not warrant investments on the same basis as those prevalent four or five years ago. For example, in the distillation of petroleum large quantities of gases are released, all of which cannot be condensed, hence electric-generation either in whole or part with the gas engine as prime mover becomes an important factor for consideration from an investment angle. Thus the steam-electric plant of the modern refinery in many respects must compete with the gas engine-driven electric plant.

The 3 new power plant steam generators are of the B & W 6 drum Stirling boiler type, having integral economizers and superheater elements suspended in 2nd pass. The boilers are designed to deliver 100,000

Data and Results of Test of Back-Pressure Type of Turbo-Generator No. 1 and 2

1. Test of No. 1 & 2—back-pressure type of turbo-generator located at Bayonne Refinery, Tide Water Oil Co. To determine approximate steam flow and water rate of units at one half load. Test conducted by E. A. Baerer.

DIMENSIONS, ETC.

2. Type of turbine—General Electric Co. 8 stage, 6 valve impulse turbine. Non-condensing, 3600 r.p.m. Force feed lubrication, hydraulic valve operating mechanism, 4500 B.hp., 150 lb. back pressure service with 650 lb. pressure, 750 deg. steam.
Generator—3375 kw., 3 phase, 60 cycle, 3600 r.p.m., 2400 v., 8 p.f. coupled to 20 kw. d.c. shaft exciter.
3. Date—Feb. 23, 1934.
4. Duration—eight (8) hr.

AVERAGE PRESSURES AND TEMPERATURES

5. Pressure in steam pipe near throttle (by gage)—649 lb. per hr.
Barometic pressure—29.14 in.
Pressure in exh. pipe near turbine (by gage)—148 lb.
6. Temperature of steam near throttle—719 deg.
Temperature of steam in exhaust near turbine—475 deg.

QUALITY OF STEAM

7. No. of degrees of superheat—220 deg.
No. of degrees of superheat in exhaust—111 deg.

TOTAL QUANTITIES

8. a. Total steam flow leaving No. 1—582,200 lb.
b. Total steam flow leaving No. 2—578,150 lb.
c. Total steam flow No. 1 and No. 2 turbines—1,160,350 lb.

HOURLY QUANTITIES

9. a. Total steam flow leaving No. 1 per hr.—72,775 lb.
b. Total steam flow leaving No. 2 per hr.—72,270 lb.
c. Total steam flow leaving No. 1 and No. 2 per hr.—145,045 lb.

HOURLY HEAT DATA

10. a. Heat units consumed by No. 1 turbine per hr.—7,495,823 B.t.u.
b. Heat units consumed by No. 2 turbine per hr.—7,443,810 B.t.u.
c. Total heat units consumed by No. 1 and No. 2 turbines per hr.—14,939,633 B.t.u.
d. Heat rejected in the form of steam leaving exhaust of
No. 1 turbine—91,405,300 B.t.u.
No. 2 turbine—90,771,120 B.t.u.

ELECTRICAL DATA

11. Average volts each phase—2350 volts.
Average amperes each phase—469 amps.
Average kilowatts No. 1—1875 kw.
No. 2—1875 kw.
Power factor—.98.

No. 1 GENERATOR

Total kw-hr. by integrating watt-hour meter—150,000 kw-hr.

No. 2 GENERATOR

Total kw-hr. by integrating watt-hour meter—150,000 kw-hr.
8 hours total kw. for excitation— 95 kw-hr.
8 hours total kw-hr.—300,000
Total output—300,095 kw-hr.

12. SPEED
Revolutions per minute—3600 r.p.m.

13. POWER
Load per cent—55 per cent.
Electrical horsepower—2510 e.hp.

ECONOMY RESULTS

No. 1 turbine

14. Heat equivalent in lb. of dry steam consumed per net kw-hr.—3.6 lb.

No. 2 turbine

Heat equivalent in lb. of dry steam consumed per net kw-hr.—3.58 lb.

No. 1 turbine

Dry steam passing through turbine per kw-hr.—38.7 lb.

No. 2 turbine

Dry steam passing through turbine per kw-hr.—38.5 lb.

15. EFFICIENCY RESULTS
Based on boiler eff. of 83 per cent and generator eff. of 93 per cent.
Heat units consumed per kw-hr. No. 1 turbine—5160 B.t.u.
Heat units consumed per kw-hr. No. 2 turbine—5130 B.t.u.
Turbo-generator loaded only 55 per cent.

lb. of steam per hr. at a pressure of 700 lb. per sq. in. They are equipped with oil fired, water cooled furnaces, using bare tubes and having six burners per furnace. The burners are of the mechanical atomizing type.

A diagrammatic layout of the fuel oil piping system is shown in Fig. 5. Two 750 bbl. storage tanks are provided. Oil is drawn from these tanks by three 7½ by 4 by 12 in. duplex steam pumps and then delivered to three fuel oil heaters and thence to the burners.

The feedwater system is shown in Fig. 6. City water from a 4100 bbl. tank is delivered to a deaerating heater by two 700 g.p.m. centrifugal pumps. From the heater the water passes into a 5 minute storage supply tank and from there to the suction lines of the boiler feed pumps. The latter, which have capacities of 562 g.p.m. against 1900 ft. head deliver the water to the main feed lines to the boilers.

Internal chemical boiler water treatment is used, employing Hagan phosphates, caustic soda and sulphate, in connection with a continuous blow down system. A complete chemical analysis of the boiler water is made daily to maintain the sulphate alkalinity ratios specified for this steam pressure and temperature by Dr. Hall. The internal chemical boiler water conditioning system was selected due to the comparatively soft water available in this city which receives its water supply from the new Wanaque reservoir in northern New Jersey, some 46 miles distant. Hardness rarely exceeds 3 gr. $CaCO_3$ per gallon.

Inspections made thus far, that is since November 6, 1933, on the effectiveness of the internal chemical treatment on scale prevention, corrosion and carry over conditions in the steam generators, indicate that holding the concentrated boiler water within the prescribed limits is very satisfactory, no evidence of incrustation being present.

A 450,000 lb. deaerating feedwater heater is provided with 3600 r.p.m. motor and steam driven 800 lb. centrifugal boiler feed pumps, the latter having force feed lubrication systems.

The two new electric generating units are General Electric machines, each consisting of an 8 stage 700 lb., 150 lb. back pressure, 3600 r.p.m. turbine direct connected to a 3375 kw., 3 phase, 60 cycle, 2400 v. alternator with direct connected exciter. These turbines exhaust directly into the 150 mains supplying steam to the refinery processes. Operating in parallel, these two generators carry the entire refinery load of 4500 kw. at an average power factor of 97 per cent. This high power factor is due to the use of a large number of synchronous motors on the system.

As already mentioned, an old 3375-kw. straight condensing type of turbo-generator taking steam at 150 lb. pressure was retained as a stand by unit for periods of inspection of the high back pressure units.

In the installation of these new units, the existing 2400 v. switchboard was revamped to accommodate new panels for the new machines.

In line with the policy of research incidental to its products, each machine is fully equipped with instruments and meters for carrying on complete lubrication tests and other useful data. The power plant thus serves the useful purpose of carrying on field tests on the manufactured products long before they are marketed.

A complete preliminary test of the new steam electric plant is presented herewith which was made for the purposes of roughly checking the new equipment characteristics in comparison with manufacturers guarantees, which show primarily that performance characteristics of the present day are predicated on a very definite basis.

A complete list of equipment used with dimensional factors are also set forth which are of interest, as well as a typical ground layout of steam generating plants and prime movers before the new high pressure steam electric plant was operating and after. During the period of construction a skeleton crew of operators was thoroughly instructed in the operation and characteristics of the new station, then they were transferred to the new station as the old equipment was shut down.

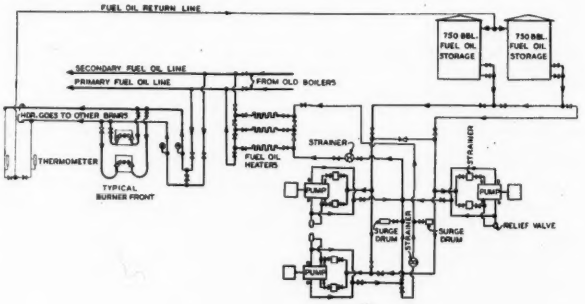


FIG. 5. LAYOUT OF THE FUEL OIL PIPING FROM STORAGE TANKS TO BURNERS

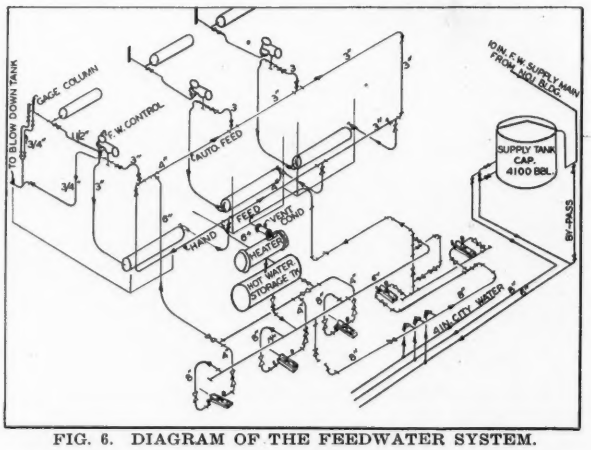


FIG. 6. DIAGRAM OF THE FEEDWATER SYSTEM.

As many opportunities presented themselves for utilizing old mechanical equipment in the dismantling of the obsolete steam generating and pumping equipment, and there being no active market for this equipment at the present time, much of this was used for fresh water and trap discharge recovery. The outstanding piece of apparatus utilized in this manner being an old 650 kw., 3600 r.p.m. condensing type of turbo-generator set.

In this set the generator was removed and a marine type of reduction gear was substituted and coupled to a 21,000 g.p.m., 105 ft. head centrifugal bronze salt water pump having a speed of 720 r.p.m.

The complete pumping unit was installed at the main salt water pumping station to augment the sup-

Data and Results of Evaporative Test

1. Test of Boilers No. 202 and 203 located at Bayonne Refinery, Tide Water Oil Co., to determine the combined efficiency at a rate of steam flow of 100,000 lb. per hr. Test conducted by E. A. Baerer.

DIMENSIONS

2. Number and kind of boilers:—3, B. & W. Stirling, 6 drum (integral economizer) type of water tube boilers; all welded drums for 713 lb. W.S.P.
3. Kind of furnace:—Bare water wall cooled on three sides, having a total volume of 4870 c.f., each furnace being equipped with 6 B. & W. oil burners of the mechanical atomizing type.
4. Burner capacity 1500 lb. f.o. per hr. each.
5. Water heating surface boiler—8727 sq. ft.
6. Superheating surface—3220 sq. ft.
   Economizer heating surface—6698 sq. ft.
   Water wall heating surface—1510 sq. ft.
7. Total water heating surface—16,935 sq. ft.
8. Date—Feb. 21, 1934.
9. Duration—8 hr.
10. Kind of fuel—No. 1 fuel oil 14-16 gr.

AVERAGE PRESSURES, TEMPERATURES, ETC.

11. Steam pressure by gage—669 lb. per sq. in.
    a. Barometric pressure—29.32 in. hg.
    b. Pressure of exhaust steam in F.W. heater by gage—4 lb. per sq. in.
    c. Pressure of f.o. entering prim. side burners—206 lb. per sq. in.
    d. Pressure of f.o. entering sec. side burners—175 lb. per sq. in.
12. Temperature of steam leaving boilers—732 deg.
    Normal temperature of saturated steam—501 deg.
13. Temperature of feedwater entering economizer—219 deg.
    Temperature of make-up water entering F.W. heater—49 deg.
14. Temperature of flue gases leaving economizer—425 deg.
    Temperature of fuel oil leaving supply tank—188 deg.
    Temperature of fuel oil entering burners—229 deg.
15. Force of draft between fan and chimney.
    a. Draft in burner wind box—1.6 in. H_2O.
    b. Draft in furnace (top)—.06 in. H_2O.
    c. Draft at economizer inlet—.41 in. H_2O.
    d. Draft at economizer outlet damper—.68 in. H_2O.
16. State of weather—cloudy.
    a. Outside temperature—28 deg.
    b. Temperature of air entering fans—41 deg.

QUALITY OF STEAM

17. Quality of steam entering superheater.
    Av. by calorimeter both boilers—99.60 per cent.
    Degrees of superheat—231 deg.
18. Factor of correction for quality—negligible.

TOTAL QUANTITIES

19. Total weight of fuel oil fired corrected for temperature and moisture free—129,450 lb.
20. Total weight of water fed to boilers and desuperheater—1,676,380 lb.
21. Total weight of water fed to desuperheater only—63,150 lb.
22. Total weight of water leaving boilers through continuous blowdown system—23,480 lb.
23. Total water evaporated—1,589,750 lb.
24. Factor of evaporation based on temperature of water entering integral economizer—1.308.
25. Total equivalent evaporation from and at 212 deg.—2,079,393.

HOURLY QUANTITIES AND RATES

26. Moisture free fuel oil fired per hr. per boiler—8091 lb.
27. Water evaporated per hr. per boiler—99,859 lb.
28. Equivalent evaporation per hr. per boiler f. & A. 212 deg.—129,960 lb.

CAPACITY PER HOUR

29. Evaporation per hr. per boiler from and at 212 deg.—129,960 lb.
    a. Boiler horsepower developed per boiler—3765 B.hp.
30. Rated capacity per hour from and at 212 deg. (Boiler only)—873.
31. Percentage of rated capacity developed (Boiler only)—431 per cent.

ECONOMY

32. Water fed per lb. of fuel oil fired—12.45 lb.
33. Water evaporated per lb. of fuel oil—12.35 lb.
34. Equivalent evaporation from and at 212 deg. per lb. of fuel oil fired—16.05 lb.

EFFICIENCY

35. Calorific value of 1 lb. of moisture free fuel oil by calorimeter—18,650 B.t.u.
36. Combined efficiency of boiler, superheater, economizer and furnace—83.4 per cent.

ANALYSIS OF FLUE GASES

37. Carbon dioxide—13.8 per cent.
    Oxygen—1.2 per cent.
    Carbon-monoxide—.0 per cent.
    Nitrogen (By diff.)—6.0 per cent.

PROXIMATE ANALYSIS OF FUEL OIL

38.

	Per cent
Carbon	85.0
Hydrogen	12.7
Oxygen	1.2
Sulphur	.2
Nitrogen	.9
	100.

39.

Heat Balance	B.t.u.	Per cent
a. Heat absorbed by steam generator	15,569	83.4
b. Heat carried away in flue gases	1,518	8.00
c. Heat loss due to burning of hydrogen	1,354	7.2
d. Unaccounted and radiation	209	1.4

ply of two synchronous motor driven pumps of the same capacity and characteristics. Tests on the old turbine operating condensing in the new location reveal an overall economy equal to present day units of equal size. This is an excellent illustration of how larger industrial plants, with a multiplicity of apparatus, have a distinct advantage in that mechanical apparatus can be applied over a wide range of uses efficiently, limited only by the ingenuity of the power engineers to apply.

Since its completion this new power plant has given excellent satisfaction and its performance has fully justified the efforts of those responsible for its design and construction. As shown by the accompanying test data, the overall efficiency of the boilers, superheater, economizer and furnace was 83.4 per cent, while the generating units under a load of only 55 per cent rated capacity delivered a kilowatt for from 5130 to 5160 B.t.u.

Steam and Power for the World's Largest Rubber Factory

ATTENTION has been called to an error in the article on the Goodyear Tire & Rubber Co. plant published in the May 1934 issue. In the third paragraph, second column, page 240, it is stated, "one Republic boiler control master sender, etc." This control equipment was manufactured and furnished by the Hagan Corp. of Pittsburgh, Pa. Republic meters and panel were used but they were included as part of the Hagan contract covering the entire combustion control system.

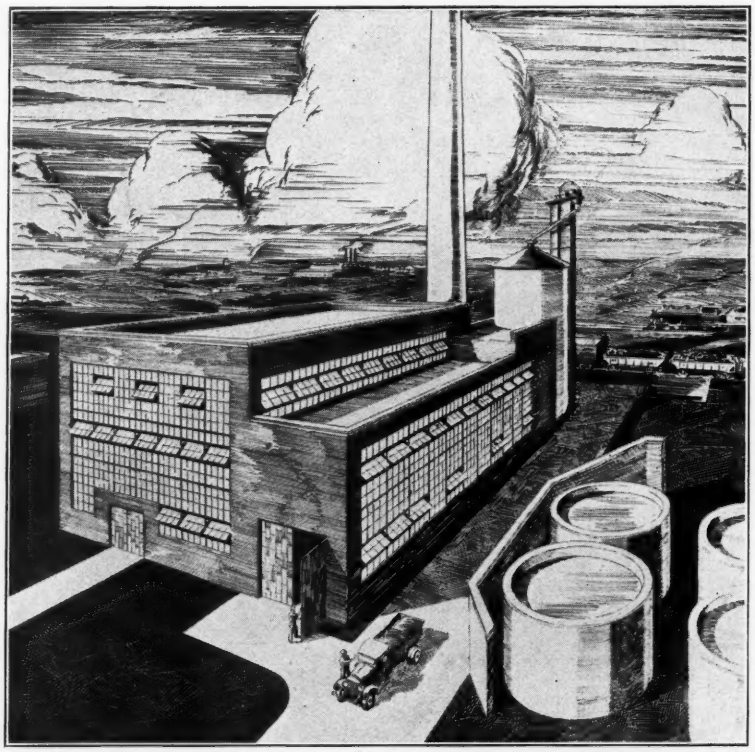
TWO OUT-OF-THE-ORDINARY installations of soil-heating cable have been made by Cleveland industries, according to General Electric engineers. The cable—nickel-chromium wire covered with asbestos, taped with varnished cambric, and encased in a lead sheath for protection from moisture—is designed primarily for horticultural and agricultural uses.

A steel plant had difficulty in the winter time with its lubricant for roll-neck bearings, which congealed in the pipe lines. Formerly a steam pipe or air duct was nested with the pipe lines; now soil-heating cable has been wound around the pipes and insulation applied. An automatic, adjustable thermostat maintains the temperature of the lubricant at the proper point, irrespective of the weather conditions.

POWER PLANT ENGINEERING June 1934

New Plant Must Offer *Paying Investment*

Recent investigations have shown a lively interest in modernization of industrial power facilities to meet present day needs with present day equipment, but in many cases there is a lack of capital, or cash, to finance projects in the usual way. In several instances these difficulties have been successfully surmounted by cooperative action of the interested parties, the projects, however, must be sound investments for all participants



CREDIT OR INSTALLMENT SELLING, one of the highlights of the New Economic Era of 1928-9, metamorphosed into a handmaiden of the New Deal of 1933-4, plays an important part in the power plant field, albeit under duress. Here, as in the automobile and household appliance field, the speculative or inflationary phase of credit has passed. New and untried made-for-the-moment economic theories have not entirely eclipsed the old values and a high commercial credit rating still remains the standard of integrity. Today, it is well recognized that risks which are too great for banks have no place in the portfolio of a manufacturer. Perhaps credit buying is more descriptive of present practice than credit selling as credit is used only where cash sales are impossible.

The Market

Until recently, municipal projects to be paid for by securities, difficult or impossible to move under present conditions, come in the "credit-wanted" class but these have been largely eliminated by PWA money. Self-liquidating industrial plants, and an occasional central station plant, constitute the largest potential market for power plant sales at present. Self-liquidating projects may be defined as those which, under the present volume of business, can add new equipment, or, replace old and inefficient equipment, thereby reducing the combined fuel and power bill sufficiently to pay for the equipment in from 2 to 3 or at most 5 yr.

Such projects are not uncommon, as business conditions and improvements in equipment combine to make the average industrial power plant a potential source of revenue which cannot be overlooked. During the last 20 yr. power plant practice has been revolutionized, yet thousands of industrial concerns are trying to meet present day competition with plants that are relics of prewar days. In charge of capable operating engineers, many obsolete plants are kept in first-class condition rendering reliable but expensive service.

Preliminary Steps

If indications are at all favorable, it is to the advantage of both management and engineering department to call in a capable consulting engineer and pay him to make a thorough survey. Engineering studies or surveys may indicate the desirability of a complete new plant, or, at this time, probably the replacement of obsolete with modern equipment or the replacement of a portion or all of the purchased power by power generated in the plant. When this is the case, obviously the most desirable method of obtaining the equipment would be to pay cash for it so as to obtain full advantage of the possible savings by eliminating the usual financing charge.

Many industrial concerns have the necessary cash reserve to finance such work but under present business conditions prefer to maintain this cash reserve even in the face of what they would normally consider

high carrying charges on the proposed investment. If cash is not to be paid from capital or reserve some form of credit must be arranged.

Credit

For the present purpose, the financing of capital or permanent expenditures for industrial purposes may be classified briefly as follows:

1. Stocks and bonds
2. Short term banks notes
3. Long term notes; a. To banks; b. To manufacturers; c. Pay-out-of-savings
4. Lease Agreements; a. Pay-out-of-savings; b. Fixed monthly payment

Sale of stocks and bonds, the usual method of raising money for permanent investments in normal times, is today practically non-existent. Not only does the present Securities Act impose stringent restrictions but the market is such that issues, if brought out, could probably be disposed of only at a prohibitive discount.

Short term banks notes are not suitable for financing work in this field and long term notes, for periods of 2, 3 or 5 yr., are equally impractical at the present time although, in the past, bankers felt that a nominal percentage of their funds, say 15 per cent, might safely be invested in paper of this kind. Section 13 of the Federal Reserve Act prohibits the rediscounting of notes made for capital expenditures, however, and, with the present necessity for maintaining a liquid condition, banks generally are not seeking this type of paper.

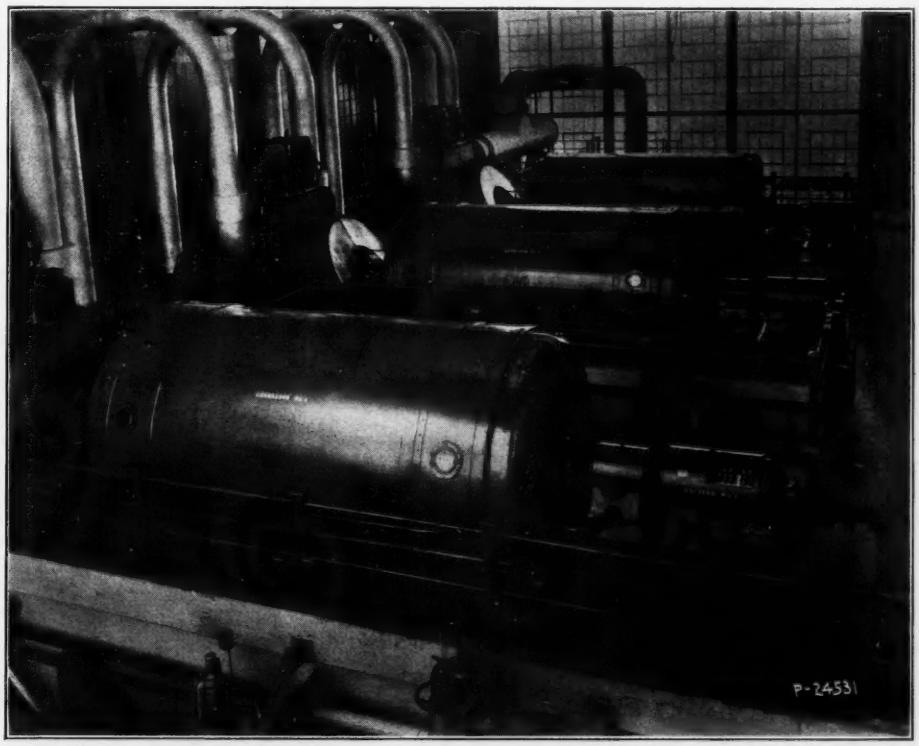
This condition may be relieved somewhat by a bill recently passed by the Senate to amend the Federal Reserve Act and make available a fund of $139,299,557 for industrial loans for periods up to 5 yr. This fund would be administered by the Federal Reserve Banks through a committee of three to five members in each district, each member to be actively engaged in business in the district in which he serves.

Commercial Bankers and Financing Companies

At the present time such loans are not available and the simplest form of credit is that extended on notes made out to manufacturers of the equipment. Some manufacturers prefer to turn these notes over to commercial bankers, in which case, the transaction approaches that of the commercial finance companies as used in the automobile industry. As a rule these arrangements are made at the time of purchase. Most commercial bankers hesitate to extend more than two years' time but occasionally this will be exceeded, or they will buy the first two years of a 3 or 4 yr. note.

This discounting of the note does not release the manufacturer of responsibility in case of defaulted payment and this secondary or contingent responsibility shows as a liability on the balance sheet of the manufacturer the same as on that of the maker of the note, so that there is a limit to the amount of equipment a manufacturer can safely sell under these terms. This double responsibility seems to be the only way commercial bankers are willing to handle notes at the present time; even then the credit of both the purchaser and seller of the equipment must be good.

Continued use of this method of financing in the automobile and household equipment fields proves that it serves a useful purpose and its use is common enough in the equipment field to indicate that it has a definite



Progress in the Power Plant Field Has Been So Great During the Past Decade that No Industrial Company Can Overlook the Possibility of Saving Thorough Modernization of the Power Plant

place there. But it is probable that ultimate economy is more important in the power plant than in the domestic field and it is felt by many that the somewhat high carrying charges will prohibit any considerable permanent use of this method of equipment financing.

Lease Agreements

Another credit plan, not new in principle but recently adapted to meet present conditions in the power plant field, is the so-called lease agreement, wherein a third party finances or underwrites the purchase and leases the plant at a specified monthly rental. So far, manufacturers have had to assume pro-rated responsibility for these monthly payments in case of default and manufacturers with limited responsibility have been required to furnish bond.

This plan is simple in principle and subject to many modifications, but the legal complications introduced by repossession laws from state to state, tax features and responsibility of various parties have to date limited its use.

When only one manufacturer is interested its application is fairly simple, but with a number of manufacturers, or if building construction is involved, the complications increase. The plan is in successful use, however, and many feel that it has a permanent value. The value to the user of the plant lies in the fact that he has the use and operation of the plant at a reasonable rental, without having it show on his books as a liability. The payments, under ideal conditions, would be arranged so as just about to equal the savings of the new over the old fuel and power costs. If the plant cannot be paid for under these conditions in from 3 to 5 yr., it is unlikely that it could be financed at this time.

Definite Plan Necessary

The following nine paragraphs summarized from literature of a prominent manufacturer who uses this plan successfully and feels that it has a permanent place in the power plant field points out the more important parts of the plan.

Before a project can be given adequate consideration, a complete description of the contemplated work must be available and satisfactory to all parties concerned, and all details must be acceptable to the finance company before financial approval will be given. In all instances the source of funds and the method of payment must be well defined from the beginning. Installments must be paid periodically, preferably on a monthly basis.

Because of the many variables involved, it is advisable that a preliminary conference be held to avoid unnecessary embarrassment and to expedite matters with the least wasted effort. At such a conference, there should be present the consulting engineer, representatives of the firm contemplating the rehabilitation work and representatives of the manufacturers.

Before any project of this kind can be given final approval, the financial responsibility of all parties must be established. In this connection the outstanding obligations of the firm having the rehabilitation work done are important. The responsibility of the contractor and the manufacturers who furnish the equipment for the work must likewise be definitely established and the different parties must be willing to accept responsibility.

These manufacturers and contractors must become responsible to the finance company for final payment of the obligation in proportion to the amount which the material and labor costs of their equipment bear to the total contract, in the event that the party having the work done defaults.

Equipment Guarantees

In no project is it permissible, from the viewpoint of the finance company, that payment be predicated on savings or economies resulting from the new installation. Any guarantee of what equipment will do must be between the manufacturers of equipment and the concerns having the rehabilitation work done. In no way will such guarantees be allowed to serve as a basis for refusal to pay the regular installments on the contract.

Because it is so difficult to set up a strictly standardized procedure, each replacement, remodeling or rehabilitation project requires individual consideration. A number of circumstances which make strict standardization impossible at this time are: Laws with regard to rights of repossession which vary from one state to another; income tax features which must be studied carefully and which depend upon the size of the contract; responsibility of the parties; interest rates and length of time over which installments must be spread. This period should be within two years, although some cases are to be considered as exceptions.

In the case of larger projects, interim financing becomes most important. This is one of the most difficult features to arrange satisfactorily in facilitating the inception of rehabilitation projects. Clear-cut arrangements must be made for the issuance of bond, checking of invoices, securing of engineers reports and the endorsement of estimates. Provision must be worked out carefully to avoid lien filing and unwarranted changing of specifications.

Difficulties Are Not Insurmountable

The following example outlines a project which includes practically all contingencies mentioned above: Plans were made to change equipment for the making of steam and electricity in a food plant. Payments were to be made monthly. Equipment by the boiler company amounted to one-third of the contract when installed. The boiler company, therefore, became responsible for the ultimate payment of one-third of the contract in event of default by the firm having the work done. The same type of responsibility was applied to other manufacturers furnishing equipment. Because of the erection of a small building, the contractor was obligated to stand his proportionate share and gave bond to that effect as did one of the suppliers of equipment with limited responsibility.

The example given above is an illustration of what has been done in a large project and was purposely chosen not only to show the many difficulties, but to illustrate that they have been solved for individual projects. Smaller projects are simpler to handle.

Pay-Out-of-Savings

Perhaps the best known and most widely used (but by a limited number of companies) self-liquidation purchase plan is the so-called "pay-out-of-savings" which may partake of both or either of the plans mentioned above. As commonly used the term is more descriptive of a sales policy than of a fixed sales contract. The widest field of application has been in the elimination or reduction of purchased power by steam or Diesel engines. Occasionally a complete power plant is contracted for, but more often only the prime mover and generator are included in the contract, the purchaser supplying the building, foundations and auxiliaries. The usual method is to require an initial down payment to be followed by monthly payments.

These monthly payments may be a fixed amount arrived at by mutual agreement of the parties involved, either with or without tests of the new equipment, or they may vary from month to month with operating conditions but with a definite specified minimum payment. The number of payments is sometimes definitely specified so that, if the savings indicated by test results are not as great as expected, the number of payments is not extended.

Under this plan, the manufacturer may retain title until the last payment, in effect leasing the equipment for a monthly rental, or he may sell the equipment outright, take a mortgage on it and accept serial notes for the payment. To a certain extent this is determined by laws in the various states, relating to rights of repossession, taxes, conditional sales and mortgages.

James Watt Set Example

It is interesting to note that this method of paying for engines was introduced by James Watt and his partner Matthew Boulton. Purchasers of the engines paid by giving Watt and Boulton one-third of the fuel saved over earlier devices.

The above remarks have related primarily to heavy equipment. In addition there is much accessory equipment necessary for plant construction but much more difficult to handle on time payment. For instance chimneys, which possess no resale value, are hardly susceptible to individual credit sales. Instruments form another special class, necessary but often trimmed off at the last moment when first cost is given too much consideration and operating efficiency and control overlooked. At least one company has handled this on a rental basis within which the customer paid cash for certain non-returnable parts and rented the balance of the equipment on a monthly basis with the option of applying the rental against the purchase price.

A survey indicates that many manufacturers have made sales on credit during the past 2 yr. Some of them have participated actively feeling that this type of business could be made profitable. Other companies have participated passively when occasion demanded, while still others have felt that financing was the function of banks rather than of manufacturers.

The attitude taken depends upon many factors, although the type of equipment manufactured and sold plays an important part. Naturally the manufacturers of valves, fittings and specialties meet less demand for credit than the manufacturer of heavy equipment. Consulting engineers and contractors play a part in creating this demand as they have services to sell and are as vitally interested in arranging terms sufficiently favorable to their clients to warrant new construction. In fact these three functions, engineering, construction and financing, have been so closely related that in the past organizations capable of carrying on the functions of all three were active in the public utility field.

Credit Sales Limited in Volume

The point to be remembered is that any method of purchase has a decided effect on the financial statements of the interested parties. It may mean a reduction in the cash position of the purchaser or increased liabilities through the issuance of notes, which, if turned over to a commercial bank, appear as a liability against the seller of the equipment as well. The lease agreement has certain advantages for the purchaser in that it does not increase his liability although it does appear as a liability against the other parties involved. The amount of credit financing is therefore limited to what responsibility various manufacturers can carry. Closer coöperation of manufacturers through the NRA activities is likely to bring about standardization of sales policies sooner than might otherwise occur. The NRA codes require the member companies to file standard prices, terms and discounts which can be changed only upon written notice with a definite time limit. Some of these further limit the terms of payment. Many codes are apparently still in a state of flux, subject to amendment and to official interpretation of the Code Authority. The reason for the difference in opinions expressed by different parties regarding certain features is perhaps well shown by the following statement:

"The Code, like a good many others, as finally approved contained only those portions which survived attack by the various NRA experts under whose eagle eye it came. The result was that a number of provisions which were perfectly clear in the original draft have become hazy in the extreme. The situation was not helped any by editorial revisions and additions which further obscured the original intent."

Summary

Thus the credit situation in the power plant industry is in a very unsettled condition. Developments worthy of consideration in these trying times have, in the past, been financed on credit and deferred payment and a number of such projects are now active. Standardization of terms or contracts would of course be impossible even in normal times so each project must be considered on its merits. In general, however, any industrial establishment having an old power plant where new equipment would pay for itself in from 2 to 5 yr. can arrange for deferred payment, provided its credit rating is good. If the rating is not such as would normally satisfy a bank, credit could hardly be expected from manufacturers who are not prepared, and have no desire, to act as bankers.

POWER PLANT ENGINEERING June 1934

Selection of Equipment for Economy

Part I. Criteria for Determining When Existing Equipment Should Be Replaced By More Efficient New Equipment. By Linn Helander

SINCE his graduation from the University of Illinois in 1915, Mr. Helander has had a broad experience in the industrial and central station power generation field of engineering having served as steam engineer for the Pittsburgh Crucible Steel Co.; engineer of tests, Ordnance Department, U. S. A.; general engineer, Westinghouse Electric & Mfg. Co.; senior engineer, U. G. I. Contracting Co.; instructor in thermodynamics and power generation at the University of Pittsburgh; and several years as consultant and research engineer. He has written many articles published in the technical press on engineering and economic subjects and his paper, "Feed Heating for High Thermal Efficiency," presented before the A. S. M. E. in 1922 was the first in this country to outline the economies in power generation obtainable by employing multiple stage heaters and bled steam for preheating feedwater.

TWO PROBLEMS arise in selecting equipment for economy. These are

(a) the problem of selecting equipment to replace existing equipment which has become obsolete, which is treated in this article, and

(b) the problem of selecting equipment to provide either additional capacity or a new service of a kind that is conducive to economy, which will be discussed in the second article of this series.

These problems are alike in that they are solved by choosing that equipment which is most conducive to low operating and capital charges. Associated with the problem of selecting new equipment to replace existing equipment, however, is the additional problem of determining when the existing equipment is obsolete.

This problem of determining when existing equipment is obsolete is usually not nearly so difficult as the text books make it. To begin with, two different forms of cost are involved. One of these is the average annual cost of operating equipment, the other is the instantaneous annual cost. The former term as used herein will be defined as that annual deposit to a sinking fund which at the end of the period over which the average is evaluated will have created a sum sufficient to compensate for the actual depreciation in the net market value of the equipment during the period and, in addition, pay operating charges, taxes, insurance, and interest; i.e., all expenses during the period, assuming that these have been allowed to accumulate, unpaid, with interest until the end of the period.

This manner of evaluating average annual charges or costs does not imply a corresponding manner of paying current expenses. It is simply a device, applicable regardless of how current expenses are paid, for taking account of the fact that interest is creditable to average annual payments on account of expenses when these payments are in excess of current expenses and chargeable against such average annual payments when these are less than current expenses.

The term instantaneous annual charges or costs, as used herein, will be defined as the annual rate of accumulation of operating charges against an equipment at any instant plus the then existing annual rate of depreciation of the net resale value of the equipment plus interest on this resale value plus the annual rate of accumulation of tax and insurance charges against the equipment at the instant. Instantaneous annual charges are derivable graphically as illustrated in Fig. 1. A formula for determining the average annual cost of operating equipment is given in Table I.

Average Costs of Services

Management is interested primarily in the long range or continuous average cost of providing services rather than in the immediate or short term cost. It does not regard as important that the rate of accumulation of charges against newly installed equipment may be temporarily high because of the rapidity with which its resale value depreciates, provided the long range cost of operating the equipment proves low.

This being the case, one may conclude that existing equipment should be replaced when so doing will reduce the long range average cost of producing the service the equipment provides. Making use of this principle for determining when existing equipment should be replaced, the conclusion is derived that such equipment should be replaced, and therefore is obsolete, as soon as the future average annual cost of operating it, evaluated for any period forward that makes this average a minimum, is in excess, no matter how slightly, of the average annual cost of operating new equipment that will provide an identical service; the average annual cost of operating the latter being evaluated for the period of its useful life determined in accordance with principles illustrated in Fig. 2. When that time arrives, the existing equipment should be replaced, although it need not be abandoned if a less exacting duty can be assigned to it. Three conditions under which obsolescence occurs arise:

(a) The instantaneous annual cost of operating the existing equipment may be increasing permanently.

(b) The instantaneous annual cost of operating the existing equipment may be temporarily decreasing.

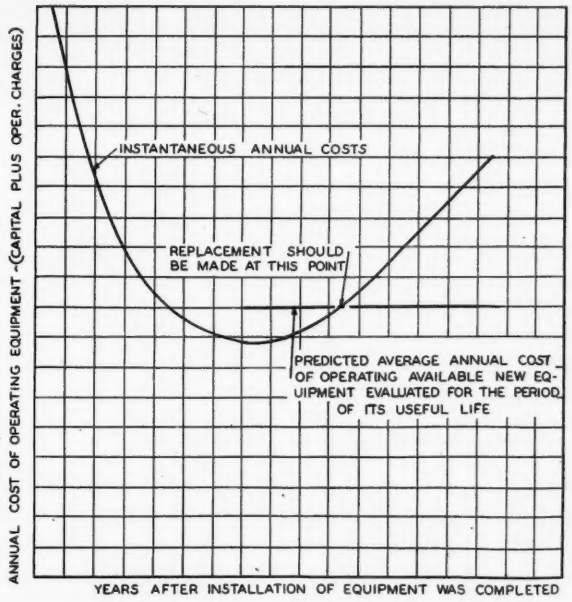

ANNUAL COST OF OPERATING EQUIPMENT - (CAPITAL PLUS OPER. CHARGES)
INSTANTANEOUS ANNUAL COSTS
REPLACEMENT SHOULD BE MADE AT THIS POINT
PREDICTED AVERAGE ANNUAL COST OF OPERATING AVAILABLE NEW EQUIPMENT EVALUATED FOR THE PERIOD OF ITS USEFUL LIFE
YEARS AFTER INSTALLATION OF EQUIPMENT WAS COMPLETED

FIG. 1. CURVE OF INSTANTANEOUS ANNUAL COST OF OPERATING AN EQUIPMENT SHOWING POINT AT WHICH REPLACEMENT SHOULD BE MADE IF CURRENT ANNUAL COSTS ARE INCREASING

Note: Instaneous annual costs = Annual rate of accumulation of operating charges at any instant + Annual interest on the existing net resale value of equipment + Annual rate of accumulation of tax and insurance charges at instant + Annual rate of depreciation of resale value of equipment at instant.

By plotting at mid-year points the actual operating charges for each year plus taxes and insurance for the year plus interest on the mid-year resale value of the equipment plus the depreciation of the resale value of the equipment during the year, a curve is obtained such as the one shown, from which the instantaneous annual cost of operating equipment at other than mid-year points can be read.

(c) The instantaneous annual cost of operating the existing equipment may be increasing, but under such conditions that a subsequent temporary reversal of trend will occur.

When Equipment Is Obsolete

When the instantaneous annual cost of operating existing equipment is permanently increasing, this equipment should be replaced as being obsolete as soon as the instantaneous annual cost of operating it is equal to or in excess of the average annual cost of operating new equipment that will provide an identical service; the average annual cost of operating the latter being evaluated for the period of its useful life.

That the existing equipment should be replaced at the time denoted above, provided the year to year cost of operating* it is increasing, is exemplified clearly by the data given in Fig. 1. There the average annual cost of operating new equipment available for replacing the old is shown as a horizontal line marked "Predicted Average Annual Cost of Operating Available New Equipment, Evaluated for the Period of Its Useful Life"; the instantaneous annual cost of operating the existing equipment as a curved line marked "Instantaneous Annual Costs." The right hand portion of the latter represents instantaneous annual costs that are increasing, the left hand portion instantaneous annual costs that are decreasing.

*The terms cost of operating, cost of operation, etc., should not be confused with the terms operating costs, operating charges, operating expenses, etc., which are used synonymously. The former, as used herein, include capital charges; the latter do not.

Assuming that the instantaneous annual cost of operating the existing equipment is increasing so that only the right hand portion of the curve of instantaneous annual costs need be considered, it will be obvious that the existing equipment should be replaced, and so is obsolete, as soon as the curve of its instantaneous annual costs intersects the line that represents the average annual cost of operating new equipment.

To maintain the existing equipment in service beyond that time is to incur year to year charges increasingly in excess of the average year to year charges that will be incurred by installing new equipment. Furthermore, it will be clear from the figure that at the moment obsolescence occurs the instantaneous annual cost of operating the existing equipment is exactly equal to the average annual cost of operating the new equipment. This substantiates the criterion for determining the date of obsolescence given at the beginning of this paragraph. Obsolescence occurring in accordance with the conditions set forth in this paragraph will be called normal obsolescence hereinafter.

Decreasing Instantaneous Annual Cost

When the instantaneous annual cost of operating the existing equipment is decreasing, which implies usually that the existing equipment is relatively young, a somewhat more complicated procedure must be followed to determine whether or not the installation of new equipment to replace the existing equipment can be justified. As indicated in Fig. 3, which exemplifies the procedure to be followed, interest in this case centers on the predicted average annual cost of operating the existing equipment during its apparent remaining useful life, this as shown in Fig. 3

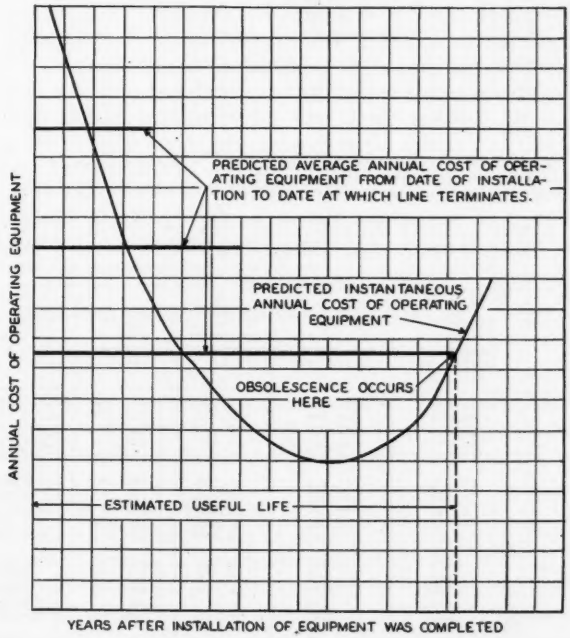

ANNUAL COST OF OPERATING EQUIPMENT
PREDICTED AVERAGE ANNUAL COST OF OPERATING EQUIPMENT FROM DATE OF INSTALLATION TO DATE AT WHICH LINE TERMINATES.
PREDICTED INSTANTANEOUS ANNUAL COST OF OPERATING EQUIPMENT
OBSOLESCENCE OCCURS HERE
ESTIMATED USEFUL LIFE
YEARS AFTER INSTALLATION OF EQUIPMENT WAS COMPLETED

FIG. 2. CHART FOR ESTIMATING USEFUL LIFE

The useful life of any piece of equipment at the time of installation may be defined as the period that is expected to intervene between the date of installation and the date at which the curve of instantaneous annual costs having turned upwards first crosses a line that represents, as indicated hereon, the predicted average annual cost of operating the equipment from the date of installation to the date at which the line terminates.

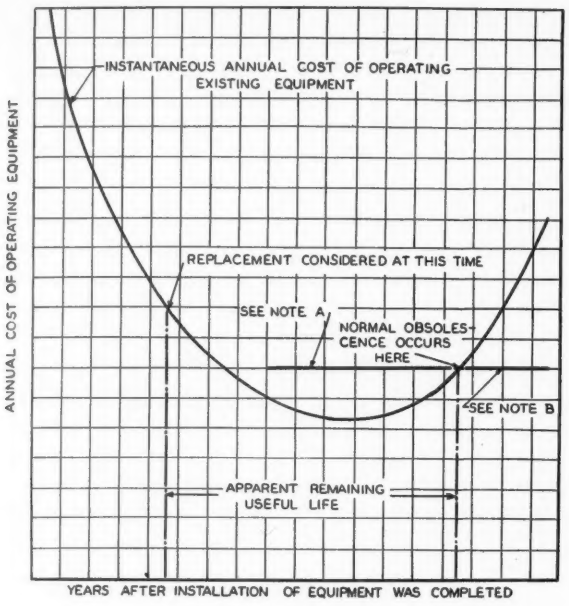

INSTANTANEOUS ANNUAL COST OF OPERATING EXISTING EQUIPMENT
REPLACEMENT CONSIDERED AT THIS TIME
SEE NOTE A
NORMAL OBSOLESCENCE OCCURS HERE
SEE NOTE B
APPARENT REMAINING USEFUL LIFE
ANNUAL COST OF OPERATING EQUIPMENT
YEARS AFTER INSTALLATION OF EQUIPMENT WAS COMPLETED

FIG. 3. DETERMINING NORMAL OBSOLESCENCE

When the average annual cost of operating an existing equipment estimated for the period of its apparent remaining useful life (A), as defined hereon, is greater than the predicted average annual cost of operating new equipment that can be used to replace the existing equipment (B), the existing equipment should be replaced, otherwise it should not be replaced.

being the number of years expected to intervene before the existing equipment becomes obsolete in accordance with the conditions for normal obsolescence just discussed. If the predicted average annual cost of operating the existing equipment during its apparent remaining useful life is less than or equal to the predicted average annual cost of operating the most economical new equipment available for the same service, the existing equipment should be retained; otherwise it should be replaced as being obsolete.

Obsolescence occurring in accordance with the conditions just set forth will occur usually either as a result of faulty selection at the time the existing equipment was installed or because of unexpected and

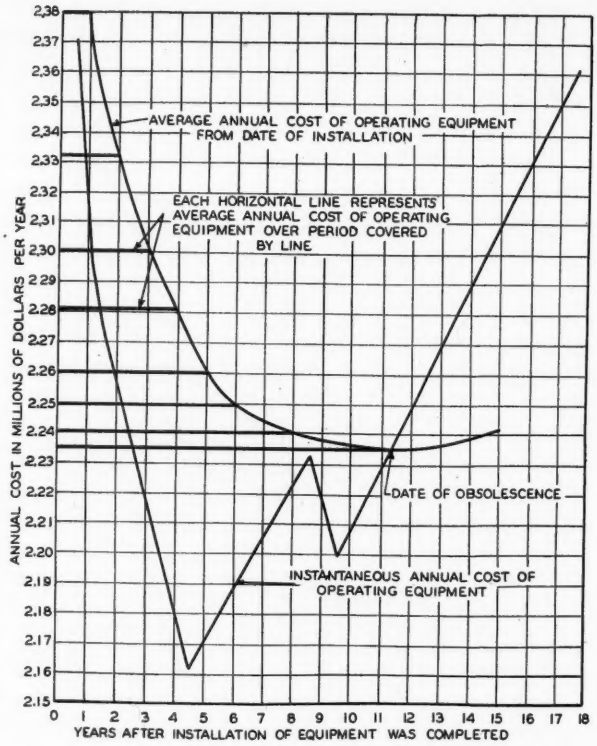

AVERAGE ANNUAL COST OF OPERATING EQUIPMENT FROM DATE OF INSTALLATION
EACH HORIZONTAL LINE REPRESENTS AVERAGE ANNUAL COST OF OPERATING EQUIPMENT OVER PERIOD COVERED BY LINE
DATE OF OBSOLESCENCE
INSTANTANEOUS ANNUAL COST OF OPERATING EQUIPMENT
ANNUAL COST IN MILLIONS OF DOLLARS PER YEAR
YEARS AFTER INSTALLATION OF EQUIPMENT WAS COMPLETED

FIG. 4. INSTANTANEOUS ANNUAL COSTS AND AVERAGE ANNUAL COSTS GIVEN IN TABLE I

Plotted to show date of obsolescence of equipment therein considered, assuming equipment will be replaced, when obsolete, by new equipment of the same kind.

unusually rapid technological advancements. It may therefore be regarded as premature obsolescence and will be so referred to hereinafter.

Temporary Reverse in Cost Trend

A case wherein the curve of the instantaneous annual cost of operating existing equipment reverses temporarily an upward trend is illustrated in Fig. 4. For this case no new difficulty is encountered. When

TABLE I. YEAR TO YEAR CHARGES AND AVERGE ANNU AL CHARGES INCURRED BY OPERATING AN EQUIPMENT

Data are hypothetical, and were prepared to exemplify procedure in determining date of normal obsolescence. Initial cost of equipment $1,000,000—Interest rate—6 per cent.

Year ended	Year to Year Charges = Mid-year Instantaneous Annual Charges					Average Annual Charges Against Equipment				
	Interest on average resale value during year	Depreciation of resale value during year	Taxes and insurance during year	Operating expense during year	Total charges during year	Annual deposit to sinking fund for depreciation, etc. See Formula I	Annual payment of insurance and taxes	Annual deposit to sinking fund for operating expense. See Formula II	Annual interest on initial cost of equipment	Total average annual charges
1	$51,000	$300,000	$20,000	$2,000,000	$2,371,000	$300,000	$20,000	$2,000,000	$60,000	$2,380,000
2	36,000	200,000	20,000	2,020,000	2,276,000	242,000	20,000	2,010,000	60,000	2,332,000
3	25,500	150,000	20,000	2,040,000	2,235,000	205,000	20,000	2,020,000	60,000	2,305,000
4	18,000	100,000	20,000	2,060,000	2,198,000	171,000	20,000	2,030,000	60,000	2,281,000
5	13,500	50,000	20,000	2,080,000	2,163,500	142,000	20,000	2,038,000	60,000	2,260,000
6	10,500	50,000	20,000	2,100,000	2,180,500	122,000	20,000	2,047,000	60,000	2,249,000
7	7,500	50,000	20,000	2,120,000	2,197,500	107,000	20,000	2,055,000	60,000	2,242,000
8	4,500	50,000	20,000	2,140,000	2,214,500	96,000	20,000	2,064,000	60,000	2,240,000
9	1,500	50,000	20,000	2,160,000	2,231,500	87,000	20,000	2,072,000	60,000	2,239,000
10	zero	zero	20,000	2,180,000	2,200,000	76,000	20,000	2,080,000	60,000	2,236,000
11	zero	zero	20,000	2,200,000	2,220,000	67,000	20,000	2,088,000	60,000	2,235,000
12	zero	zero	20,000	2,220,000	2,240,000	59,000	20,000	2,096,000	60,000	2,235,000
13	zero	zero	20,000	2,240,000	2,260,000	53,000	20,000	2,103,500	60,000	2,236,000
14	zero	zero	20,000	2,260,000	2,280,000	47,600	20,000	2,111,000	60,000	2,238,600
15	zero	zero	20,000	2,280,000	2,300,000	43,000	20,000	2,118,000	60,000	2,241,000

Formula I : Annual deposit to sinking fund for depreciation, etc. =

$$(\text{Initial cost-resale value})\ r \div \left[(1+r)^n - 1\right]$$

Formula II : Annual deposit to sinking fund for operating expense =

$$\left[A(1+r)^{n-1} + B(1+r)^{n-2} \text{------} + Y(1+r) + Z\right] r \div \left[(1+r)^n - 1\right]$$

r = rate of interest charge in percent
n = number of years after installation of equipment

A = first year's operating expense

B ----Y, Z = second year's operating expense and successive following years' expense down to the last.

a line representing the average annual cost of operating new equipment intersects two upwardly directed parts of a curve representing the instantaneous annual cost of operating existing equipment, normal obsolescence will occur at the point of intersection the more remote from the vertical axis; i.e., at the point that gives the existing equipment the longer life. Premature obsolescence, however, may occur at the other point of intersection. In order to illustrate the application of the principles set forth for determining the date of normal obsolescence, calculations for determining that date for an undefined equipment are presented in Table I. The following assumptions were made:

Initial cost of equipment $1,000,000.
Rate of depreciation—as indicated in table.
Interest rate 6 per cent.
Insurance and taxes per year $20,000.
Operating charges per year—as shown in table.

Equipment that will replace existing equipment when latter becomes obsolete to be the same as the existing equipment.

Prices, unit labor costs, etc., to remain unchanged during life of existing equipment and that of the equipment that will replace it.

The results are plotted in Fig. 4. They show that obsolescence occurs shortly after the eleventh year, assuming that the existing equipment will be replaced by new equipment of the same kind. At that time, the average annual cost of operating the existing equipment is seen to be a minimum. Should equipment be made available that will provide the same service as that being supplied by the existing equipment but at a lower annual average cost, obsolescence would occur earlier. Should the service be obtainable from new equipment, for example, at an average annual cost of $2,200,000, which is $35,000 below that at which the existing equipment supplies it, the existing equipment would become obsolete during the seventh year.

(To be continued.)

The Law of *Sales Contracts*

In Many Instances It Is Important for Engineers to Be Able to Determine the Legal Standing of Parties to a Sale Contract. This Is Necessary in Order That Employers Represented by Engineers Shall Have Their Legal Rights Protected. By Leo T. Parker, Attorney at Law, Cincinnati, Ohio

WHAT IS A CONTRACT of sale? A contract of sale consisting of a signed order, or an agreement made by mail, acquires the same legal status as any written contract. The laws which control the latter are effective with respect to the former. One of the oldest rules of the law is that verbal agreements do not change in the least the meaning of a written contract of sale.

Therefore, where a signed order is in controversy, testimony which relates to verbal agreements between the purchaser and seller will not be considered by the courts as evidence to vary the meaning of the written contract of sale unless the verbal assertions are fraudulent. On the other hand, a verbal contract of sale may be varied by later verbal agreements, and a written order may be modified by subsequent written agreements.

Usually, litigations between purchasers and sellers result from failure of the seller to deliver the quality of goods specified in the contract, or negligence of the seller to make prompt delivery. Therefore, it is important to know that the law is well settled that where a seller repudiates a valid contract of sale and refuses longer to be bound by it, the purchaser may pursue either of the three following remedies:

He may treat the contract breached and notify the seller to pay damages; or he may endeavor to continue to fulfill the contract, being at all times himself ready and able to perform his obligations, and at the expiration of the contract he may sue and recover the damages and anticipated profits; or he may treat the seller's breach as an end to the contract, and file suit immediately without sending notification to the seller of the intended legal action, and recover all damages sustained and the profits he would have made on the merchandise if the seller had not breached the agreement; or he may accept the shipment, which does not conform with the contract, and reduce the contract price an amount equal to the difference between the original contract price and the actual market value of the goods delivered.

Breach of Contract

A great many controversies between buyers and sellers originate from breach of a sale contract. It is well known that a firm or person who breaches a contract is liable in damages for loss of profits and other financial losses sustained by the other contracting party as a result of the breach.

Broadly speaking, a breach of a sale contract is any act in violation to the terms of the agreement. Obviously, any firm or person may defend a suit on contentions, but if such contentions are unworthy, and not substantially proven, the jury will not be induced to render a favorable verdict.

On the other hand, it is important to know that neither a buyer nor a seller is entitled to recover damages based upon a breached contract, unless the testimony clearly indicates that actually a breach occurred. In other words, the mere fact that a seller states that he intends to breach a contract, is not sufficient justification for the purchaser to recover damages.

Purchaser Must Promptly Rescind Sales Contract

Generally speaking, a purchaser is bound to cancel promptly a contract of sale where the rescission is based

on the grounds that the subject of the sale does not equal the guarantee given by the seller. Also, it is especially true that a payment made by a purchaser, after complaint that he is not satisfied, indicates that he did not promptly rescind the contract.

For instance, in Abram V. Arrighini, 232 N. W. 196, it was disclosed that in February a person purchased a machine on credit. Upon trial the machine did not operate to the purchaser's satisfaction and he complained to the seller. Parts of the machine were sent to the manufacturer's plant for repairs. Although the purchaser complained that the machine was not satisfactory he paid $400 on his account in June. Finally in September he refused to make further payments and the seller filed suit to recover the balance due. The purchaser contended that he was not obligated because the machine failed to prove equal to the guarantee given by the seller when it was purchased. Since the purchaser did not promptly rescind the contract, however, the court held the seller entitled to recover the balance due, stating the following important law:

"Under defendant's (purchaser's) version he had a right, at one time, to rescind. That right survived mutual efforts to repair defects but called for prompt exercise, after plaintiff (seller) refused further cooperation, and was lost by delay and recognition of obligation to pay and by the payment of $400."

On the other hand, it is important to know that neither a buyer nor a seller is bound by a statement, relating to a contract previously signed, if such supplementary statement was not intended by both parties to become a part of the original agreement.

Seller Must Act in Good Faith

It is well established law that if a seller misrepresents his product and the purchaser is induced by such misrepresentations to enter into a contract of sale, the latter may refuse to fulfill his obligations. Also, he may sue and recover full damages and the anticipated lost profits.

The "legal" meaning of misrepresentation or deceit means that the complaining party can prove all of the following facts:

(1) There must be conduct—acts, language, or silence—on the part of the defrauding party amounting to a representation or a concealment of material facts from the other party;

(2) These facts must be known to the defrauding party at the time the transaction is completed;

(3) The truth concerning these facts must be unknown to the other party claiming the fraud at the time when it was acted upon by him;

(4) The acts of the defrauding party must be done with the intention, or at least with the expectation, that the other party will be influenced;

(5) The conduct or promises of the defrauding party must be relied upon by the other party and, thus relying, he must be led to act upon it.

Therefore, it is well settled that although a seller misrepresented his product, or practiced deceit upon a purchaser, the latter has no legal recourse if the testimony shows that the deceitful statements were not relied upon by the purchaser. Moreover, a deceitful or misleading statement made after the sale contract is completed is not actionable deceit.

Authority of Salesman

Neither a manufacturer nor a buyer is liable for the acts of his agent, unless the agent is placed by his employer in such position which implies that the agent has authority to do the act in question. Therefore, under ordinary circumstances, the intended meaning of contracting parties cannot be determined by reference to agreements made between a purchaser and a salesman.

In other words, the sole implied authority of a salesman is to solicit orders and send them to his employer for acceptance. Moreover, either the buyer or the manufacturer may cancel a written or a verbal order given to the manufacturer's agent, provided the cancellation is mailed before the salesman's employer accepts the order. Another important established rule of the law is that a purchaser cannot change or vary the obligations of a written contract of sale by introducing testimony showing that the salesman made oral promises.

Yet, if the employer places his salesman in such relation to the purchaser that the latter is compelled to rely upon statements made by the salesman, with respect to the quality of the merchandise, the law implies that the employer is responsible for the natural obligations thus effected.

Also, it is well established that if a salesman deceives a purchaser when soliciting an order, and makes fraudulent statements by which the latter is induced to sign a contract of sale, the purchaser may refuse to accept and pay for the goods. This is so because an employer is responsible for all the fraudulent acts performed by an employe while acting within the scope of his authority.

While it is true that a printed notification on an order form, signed by a purchaser, ordinarily relieves the seller from responsibility for verbal guarantees made by his salesman, yet a seller always is liable for promises or acts of his representative which may be classified as fraudulent or legally deceitful.

Numerous courts have held that a seller's representative who remained silent, and does not inform a prospective buyer of known defects in equipment, is guilty of legal deceit.

Authority to Purchase

Another important point of the law on this subject relates to the authority of an engineer to make purchases. Obviously, the employer is liable for any and all contracts of sale made by an employe who acts within the scope of his authority.

On the other hand, it is important to know that if an engineer exceeds the authority and his employer refuses to accept and pay for the purchased merchandise or equipment the seller may hold the engineer personally responsible. Also, the engineer may be personally liable if he signs a contract with his own name without including in the contract his employer's name. When signing contracts of sale the engineer should be certain that the body of the contract contains the employer's name and the signature should be affixed as follows:

"The Merkel Co.,
Per (engineer's name)."

Selection of STEAM TURBINES *for* INDUSTRIAL PLANTS

From the demand curves for power and process steam in an industrial plant to the selection of the proper turbine for the conditions, the necessary steps in the problem are indicated in this case study

By K. S. KRAMER
Turbine Engineer
Westinghouse Electric & Mfg. Co.

MANY INDUSTRIAL plants require process steam at one or more pressures, frequently generating it for the purpose and purchasing power from an outside supplier. The steam is usually generated at a pressure sufficiently above the highest required for process to compensate for line drop while that for heating and for processes requiring lower pressure is throttled or reduced to the desired pressure through reducing valves. Such methods of operation persist despite the fact that during the past 10 yr. many turbines have been built to order to serve the purpose of these reducing valves, thereby producing as a by-product, power which formerly had to be purchased. This results in savings of such magnitude as to enable the original installation costs to be recovered in a relatively short period of operation.

In this article a typical case will be taken up showing a method which could be used to determine the proper turbine types and sizes. The procedure would be practically the same regardless of the type of industry involved and would be unaffected by differences in power and steam requirements from those of the example cited, although the conclusions might, of course, be radically different.

Steam and Power Demands

For the particular plant to be discussed, the process steam and power requirements are shown on Fig. 1. As will be noted, the manufacturing processes require steam at two pressures, 90 and 15 lb. per sq. in. ga. while during the winter months there is an additional demand for steam at 5 lb. per sq. in. ga. for building heating.

Because of the nature of the 5-lb. steam demand, it is advisable to bleed from one zone in the turbine all of the 15 and 5-lb. steam required, the 5-lb. steam being taken off through a reducing valve. These pressures are too close together to warrant the added complexity of turbine design entailed by the use of two zones. Furthermore the required quantity of 5-lb. steam is small, for, as will be noted from Fig. 1, no steam is required at this pressure for three months of the year. The process steam demands can, therefore, be combined as shown in Fig. 2.

As the present boilers are suitable only for steam pressures below 150 lb. per sq. in. ga. and since the greater proportion of the process steam demand is just slightly less than this pressure, a new boiler plant will be required to generate steam at a higher pressure. The pressure and temperature chosen are 400 lb. per sq. in. ga. and 175 deg. F. superheat at the turbine throttle. These conditions result in approximately the temperatures required for the process demands and at the same time provide as much by-product power as can be obtained without involving the additional cost of employing the next higher initial pressure standard of 600 lb. per sq. in. ga.

With the load and process steam demands as given in Figs. 1 and 2 and turbine throttle conditions as given above, possible types and sizes of turbines can be approximately determined to meet these conditions. Having determined possible types and sizes, the performance, price, space requirements, etc., can then be obtained from the turbine manufacturer and the best solution accurately determined.

Turbines have been developed and built to meet almost any industrial application. The two main types

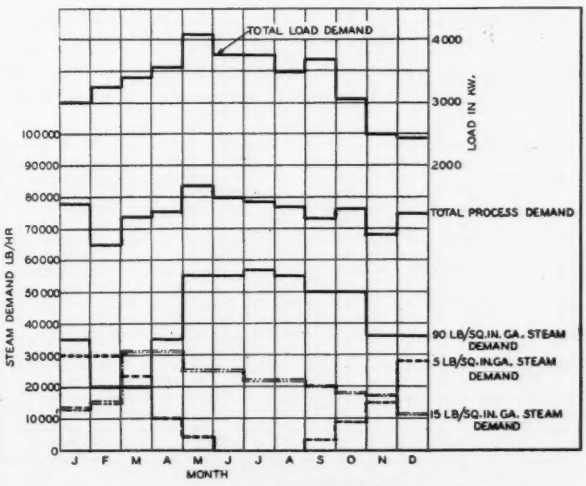


FIG. 1. PROCESS STEAM AND POWER REQUIREMENTS IN A TYPICAL INDUSTRIAL PLANT.

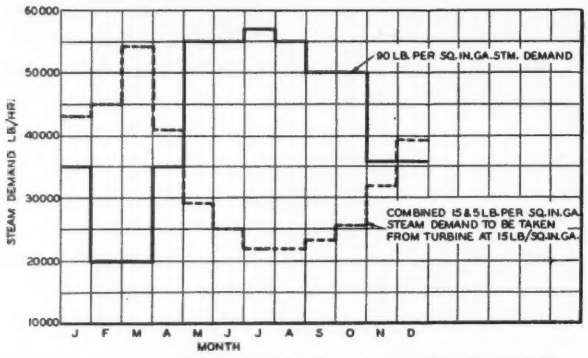

90 LB. PER SQ. IN. GA. STM. DEMAND
COMBINED 15 & 5 LB. PER SQ. IN. GA. STEAM DEMAND TO BE TAKEN FROM TURBINE AT 15 LB./SQ. IN. GA.
STEAM DEMAND LB./HR.
60000
50000
40000
30000
20000
10000
J F M A M J J A S O N D
MONTH

FIG. 2. COMBINED PROCESS STEAM DEMAND TO BE SUPPLIED FROM TURBINE.

manufactured are condensing and non-condensing. Each type has been built for extraction of steam non-automatically from one or more pressures and automatically from one or two pressures, in addition to non-automatic extraction. Turbines have been built for induction as well as extraction of steam and in some cases extraction at one pressure and induction for another. Inlet pressures vary from several pounds absolute to 1400 lb. per sq. in. and can be built for higher pressures if desired. In some cases turbines are supplied with steam at two pressures. Most turbines can be designed for low pressures and temperatures and later by minor changes made suitable for efficient operation with much higher inlet conditions. With all these types available, it can readily be appreciated that the selection of the most economical and practical turbines is, in many cases, a rather complicated problem.

For the particular problem being discussed, it can readily be seen by inspection that one possible type turbine for the conditions set forth is a 5000-kw unit of the double extraction type, bleeding steam at 90 lb. per sq. in. ga. and 15 lb. per sq. in. ga.

The other alternative is to obtain all process steam from a non-condensing, single extraction type unit and if necessary generate additional power on a condensing cycle.

Determination of Turbine Rating

With the aid of Fig. 3 and a steam chart, the rating of the non-condensing single bleeder can be approximately determined. Consider the extraction turbine for purposes of calculation, as consisting of two turbines exhausting at two different back pressures, in this case one at 90 lb. per sq. in. ga. and one at 15 lb.

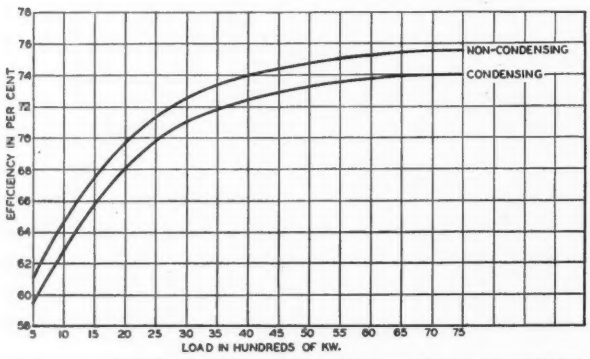


FIG. 3. APPROXIMATE RANKINE CYCLE EFFICIENCY RATIOS OF TURBO-GENERATORS.

per sq. in. ga. From the steam charts, the adiabatic heat drops can be obtained as follows:

Lb. per sq. in. ga.	Total heat B.t.u. per lb.	Entropy
415—175° F. superheat	1318	1.596
105	1186	1.596
30	1091	1.596

1318 — 1186 = 132 B.t.u. drop to 90 lb. per sq. in. ga.
1318 — 1091 = 227 B.t.u. drop to 15 lb. per sq. in. ga.

Maximum steam required at 90 lb. is 57,000 lb. per hr. with corresponding demand for 22,000 lb. per hr. of 15-lb. steam.

Maximum steam required at 15 lb. is 54,000 lb. per hr. with corresponding demand for 20,000 lb. of 90-lb. steam.

A rating is chosen at random and the corresponding efficiency taken from Fig. 3. For the case at hand select 2500-kw. with corresponding efficiency at 71.3 per cent. This then gives:

0.713 × 132 or 94.1 B.t.u. per lb. converted into useful work.

0.713 × 227 or 161.8 B.t.u. per lb. converted into useful work.

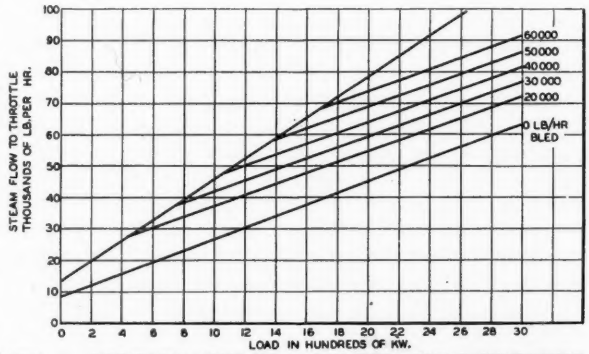


FIG. 4. PERFORMANCE OF A 3000-KW. NON-CONDENSING BLEEDER TURBINE—STEAM AT 400 LB. 175 DEG. SUPERHEAT, EXHAUST 15 LB., BLEEDING AT 90 LB.

Since 3415 B.t.u. are the equivalent of one kilowatt hour, the pounds of steam required per kilowatt-hour are

$\frac{3415}{94.1}$ = 36.3 from 400 lb. ga. to 90 lb. ga.

$\frac{3415}{161.8}$ = 21.1 from 400 lb. ga. to 15 lb. ga.

Now for the quantities of process steam given above, the kilowatts generated are obtained as follows:

$\frac{57{,}000}{36.3}$ = 1570 kw. from steam extracted at 90 lb.

$\frac{22{,}000}{21.1}$ = 1043 kw. from steam exhausted at 15 lb.

2613 kw. total

$\frac{20{,}000}{36.3}$ = 551 kw. from steam extracted at 90 lb.

$\frac{54{,}000}{21.1}$ = 2560 kw. from steam exhausted at 15 lb.

3111 kw. total

The total loads obtained indicate a nominal rating of 3000 kw. which is sufficiently close to the 2500 value used in determining the efficiency. A much larger discrepancy would warrant some "cut and try" for closer agreement.

A request to the turbine manufacturer can then be made for the necessary data on a 3000-kw. non-condensing bleeder to satisfy the process requirements as given above.

The performance of this unit is shown in Fig. 4. With the aid of this performance chart, Fig. 5 can be made and, as will be seen, the loads to be generated by the condensing cycle varies from 0 to a maximum of 1500-kw. A straight condensing unit of 1500-kw. capacity, operating with steam conditions of 400 lb. per sq. in. ga., 175 deg. F. superheat and 28-in. vacuum would, therefore, be required to supply the additional power.

These two units would satisfy the conditions as set forth in Fig. 1 but would make no provision for peaks, spare units or future growth.

Three Solutions Considered

There are three outstanding solutions to meet present demands, future growth and to provide a spare unit.

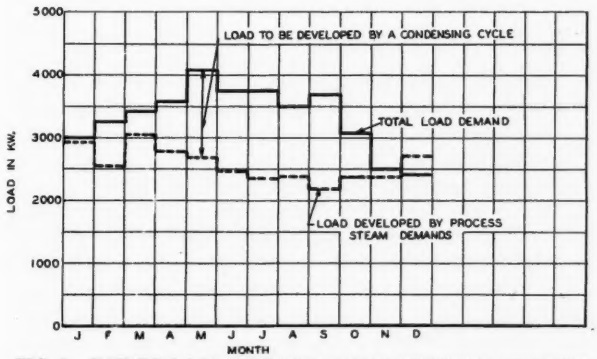

LOAD TO BE DEVELOPED BY A CONDENSING CYCLE
TOTAL LOAD DEMAND
LOAD DEVELOPED BY PROCESS STEAM DEMANDS
LOAD IN KW.
MONTH
J F M A M J J A S O N D

FIG. 5. POWER LOAD DEMAND CURVE SHOWING DIVISION BETWEEN PROCESS STEAM AND CONDENSING CYCLE.

"A"

1—3000-kw. non-condensing bleeder 400 lb. per sq. in. ga., 175 deg. F. superheat, 15 lb. per sq. in. ga., bleeding at 90 lb. per sq. in. ga.
1—2000-kw. condensing 400 lb. per. sq. in. ga., 175 deg. F. superheat, 28 in., no bleeding.
1—3000-kw. bleeder 400 lb. per sq. in. ga., 175 deg. F. superheat, 28 in., bleeding at 15 lb. per sq. in. ga.

"B"

2—3000-kw. non-condensing bleeder 400 lb. per. sq. in. ga., 175 deg. F. superheat, 15 lb. per sq. in. ga., bleeding at 90 lb. per sq. in. ga.
1—2500-kw. condensing 400 lb. per sq. in. ga., 175 deg. F. superheat, 28 in., no bleeding.

"C"

2—5000-kw. double bleeders 400 lb. per sq. in. ga., 175 deg. F. superheat, 28 in., bleeding at 90 and 15 lb. per sq. in. ga.

Arrangement "C" is discarded because of the necessity of doubling the normal capacity to obtain a spare unit which would, of course, mean a considerable increase in cost over "A" and "B." In addition, this arrangement cannot be as efficient or as flexible as "A" and "B."

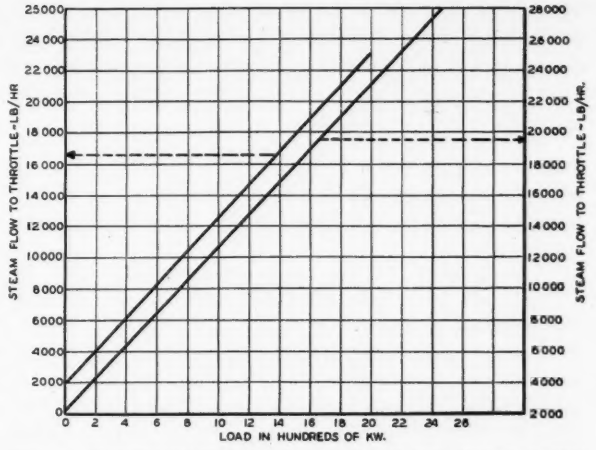


FIG. 6. PERFORMANCE OF 2000 AND 2500-KW. CONDENSING UNITS—400 LB., 175 DEG. SUPERHEAT STEAM AND 28 IN. VACUUM.

Normal operation of "A" would employ the first two units while the third unit would protect against load and steam demand swings. This third unit would also be used as a spare for the 2000-kw. condensing unit or a spare for supplying 15 lb. per sq. in. ga. steam in case the 3000-kw. non-condensing bleeder were out of service. In this latter case, the 90 lb. per sq. in. ga. steam would have to be taken directly from the boilers through reducing valves and possibly de-superheaters.

With the 3000-kw. non-condensing bleeder out of service, the 3000-kw. condensing bleeder would furnish the 15 lb. per sq. in. ga. steam demand and carry its full rated load, the remainder of the plant load being carried by the 2000-kw. condensing unit.

Normal operation of "B" would be the same as that for "A." The condensing unit was increased to 2500 kw. to be more certain of providing for peaks of the near future; this margin being furnished in "A" by the 3000-kw. condensing bleeder.

In the event of the first non-condensing turbine being out of service, the original form of operation

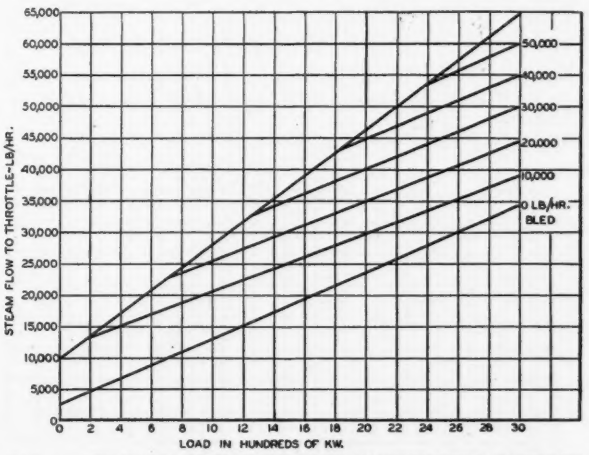


FIG 7. PERFORMANCE OF 3000-KW. CONDENSING BLEEDER TURBINE—400 LB., 175 DEG. SUPERHEAT STEAM, 28 IN. VACUUM, BLEEDING AT 15 LB.

would be continued by employing the second non-condensing bleeder. If the condensing unit were down, it would be essential to obtain any condensing capacity required by operating the second non-condensing bleeder under speed control.

Since under normal operation, the efficiency is very closely the same for "A" and "B," the deciding factor between the solutions will be primarily initial investment and efficiency of operation for other than normal conditions.

Arrangement "B" is naturally less costly as it involves only two types of units and less condensing equipment.

Comparison of Operating Economies

Consider arrangement "A" for the month of May with the non-condensing bleeder out of service. With the condensing bleeder generating its full rated load of 3000-kw. and bleeding 29,000 lb. per hr. at 15 lb. per sq. in. ga., the required throttle flow will be 49,500 lb. per hr. (Fig. 7). The remaining 1100-kw. are generated on the straight condensing unit, requiring 13,600 lb. per hr. (Fig. 6) while the required 55,000 lb. per hr. of 90 lb. per sq. in. ga. steam is taken direct from the boiler. This gives a total steam demand from the boilers of 118,100 lb. per hr. as against 100,800 lb. per hr. for normal operation or an increase of 17,300 lb. per hr.

With the condensing unit of "B" out of service and operating the non-condensing bleeder under speed control, the steam thrown away to atmosphere would not reach serious proportions if the shut down occurred during January to April inclusive, or during November and December. There would, however, be considerable steam thrown to the atmosphere if the shut down occurred during the months of May to September inclusive. For the month of May, one non-condensing bleeder would generate 2700 kw. with 84,000 lb. per hr. to throttle while satisfying both the 90 lb. per sq. in. ga. demand of 55,000 lb. per hr. and the 15 lb. per sq. in. ga. demand of 29,000 lb. per hr. This would leave 1400 kw. to be generated on the second bleeder with a resultant throttle flow of 31,000 lb. per hr. which would in turn be thrown to the atmosphere. This gives a total demand from the boilers of 115,000 lb. per hr. as against 100,900 lb. per hr. for normal operation or an increase of 14,100 lb. per hr. Arrangement "B" is, therefore, more efficient than "A" under these conditions. It should be noted that when the second non-condensing turbine exhausts to atmosphere, the back pressure is decreased from 15 lb. per sq. in. ga. to 5 lb. per sq. in. ga., reducing the required throttle flow from 34,500 to 31,000 lb. per hr.

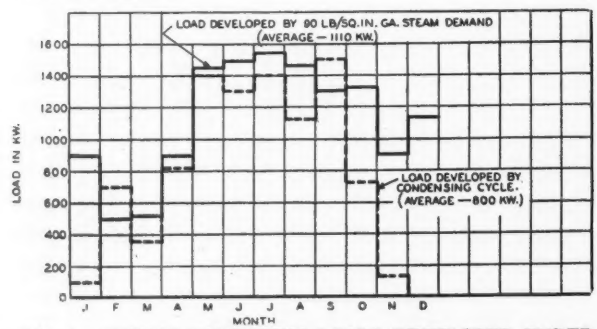


FIG. 8. CURVES COMPARING LOADS DEVELOPED UNDER CASE B.

Referring to Fig. 8, it will be noted that the average load developed by the 90 lb. per sq. in. ga. steam demand is 1110 kw., while the average load required of the condensing cycle is 800 kw.

In the case of the non-condensing bleeder of "A" being out of service, the 1110 kw. generated by the 90 lb. per sq. in. ga. steam will have to be obtained from the condensing cycle on the condensing bleeder. This, together with the falling off in efficiency on the cycle of the 15 lb. per sq. in. ga. steam, means an average additional flow of approximately 15,000 lb. per hr.

With the condensing unit of "B" out of service, the 800 kw. originally developed on a condensing cycle will have to be developed on the non-condensing cycle. On the condensing cycle this load requires 10,600 lb. per hr., while on the non-condensing cycle the same load requires 21,500 lb. per hr. or an increase of 10,900 lb. per hr. as compared to the 15,000 lb. per hr. increase for "A."

The logical conclusion would be the selection of arrangement "B" since

1. The efficiency of "B" is practically the same as for "A" for normal operation.
2. The efficiency of "B" is a little better than that for "A" under emergency or any other than normal operation.
3. Taking one of the non-condensing units out of service for "B" still gives the normal operating cycle while taking any one of the three units out of service for "A" changes the operating cycle from normal with the resulting decrease in efficiency.
4. Arrangement "A" has three different types of units while "B" has but two with two of the three units duplicates. This requires carrying of fewer spare parts.
5. The cost of "B" is from 5 to 10 per cent less than for "A" even though "B" provides more total kilowatts.

Where the load and steam demands make large swings above and below the average, data similar to that for Fig. 1 should be considered for maximum and minimum values as well as the average.

It is presumed, of course, that the average industrial power plant has records available of such important data so that compilation of the information in the manner shown on Fig. 1 could readily be accomplished. If some such procedure as outlined above were used during the negotiation stage of purchasing power units, it would enable the purchaser to give the turbine manufacturers the information required to design units best suited for the conditions under which they are to operate. It would not only result in more efficient units, but would mean assurance to the plant engineer of not finding a misapplication after installation of the equipment.

Wyandotte, Michigan, Expands Power Facilities

On the list of equipment accompanying the description of the new municipal power station at Wyandotte, Mich., water walls were credited to the American Engineering Co. instead of to Combustion Engineering Co., Inc., which furnished these water walls as part of the boiler contract.

Edison Electric Institute *meet June 4 to 7 at* Atlantic City

THE EDISON Electric Institute will hold its second annual convention at the Hotel Traymore, Atlantic City, N. J., June 4-7 inclusive.

Four general sessions, all of which will be open to anyone interested in the electric light and power industry, will be held during convention week, and in addition a number of committees of the Institute have called meetings during the convention period. The general sessions will be held during the mornings of Tuesday, June 5; Wednesday, June 6; Thursday, June 7 and on the evening of Wednesday, June 6.

Convention headquarters will be at the Traymore Hotel, where all meetings will be held, and where the registration and information desk, executive office and railway ticket validating offices will be located. A spacious hall will be provided by the hotel for the general sessions, and arrangements have been made for small conference rooms to accommodate the meetings of the several committees.

Thoughtful attention is being given to the details of management of the convention, and every effort will be made to provide for the comfort and convenience of delegates. The registration and information desks will be at the service of delegates and members of the general office staff of the Institute will also be glad to extend all courtesies possible. Likewise, hotel men and public officials of Atlantic City will be anxious to make the stay of visitors a pleasant one.

The attractions of the famous ocean resort, in all probability, are well known to most of those who will attend the convention, and the location of convention headquarters is ideal for combining business with vacation relaxation. The adjournment of the convention on Thursday will leave free a long week-end that will probably be utilized by many for relaxation on the sands of the beach, or at the excellent golf clubs in the vicinity.

To give the ladies attending the convention an opportunity to meet old friends and make new ones a tea will be given in the Rose Room of the Hotel Traymore, from 4 p. m. to 6 p. m., June 4. On Monday evening there will be dancing for convention guests. The dance will be held in the American Dining Room, adjoining the main lobby of the Traymore Hotel.

First General Session

The first session will convene at 10 o'clock Tuesday morning, June 5, when President George B. Cortelyou will deliver the opening address. A portion of his address will be concerned with the Institute's progress since its organization last year, and will include a report on its major activities and accomplishments that should be of great interest to members. Edward Reynolds, Jr., treasurer of the Institute, and Bernard F. Weadock, vice-president and managing director, will discuss the Institute affairs which come within their special jurisdiction.

At this same session an important "Plan for Determining Costs of Service in the Electrical Industry" will be presented by Hudson W. Reed, management engineer, The United Gas Improvement Company, Philadelphia. Discussion of the plan will be made by Arthur H. Kehoe, vice-president, The New York Edison Company; Mark Eldredge, chief engineer, Memphis Power and Light Company, and Norman R. Gibson, vice-president, Niagara Hudson Power Corporation, Buffalo.

Second General Session

The second general session, beginning at 10 a. m. Wednesday morning, June 6, will be devoted to sales and merchandising problems. The first address on the program will be given by George E. Whitwell, chairman of the Sales Committee of the Institute and vice-president of the Philadelphia Electric Company. Mr. Whitwell will have as his subject "The Business of Getting Business." Allen L. Billingsley, president, Fuller & Smith & Ross, Inc., Cleveland, will discuss the "Economics of an Electrical Home." T. K. Quinn, vice-president, General Electric Company, New York, has accepted an invitation to present the facts and offer practical solutions on "Facing Competition."

James E. Davidson, president of the Nebraska Power Company, will discuss "Dealer Co-ordination As Aid in Load Building." The concluding event of this session will be a novel and instructive demonstration of "Light and Vision—The New Partnership," a presentation of the Better Light—Better Sight Committee, M. E. Skinner, Niagara Hudson Power Corporation, Buffalo, Chairman.

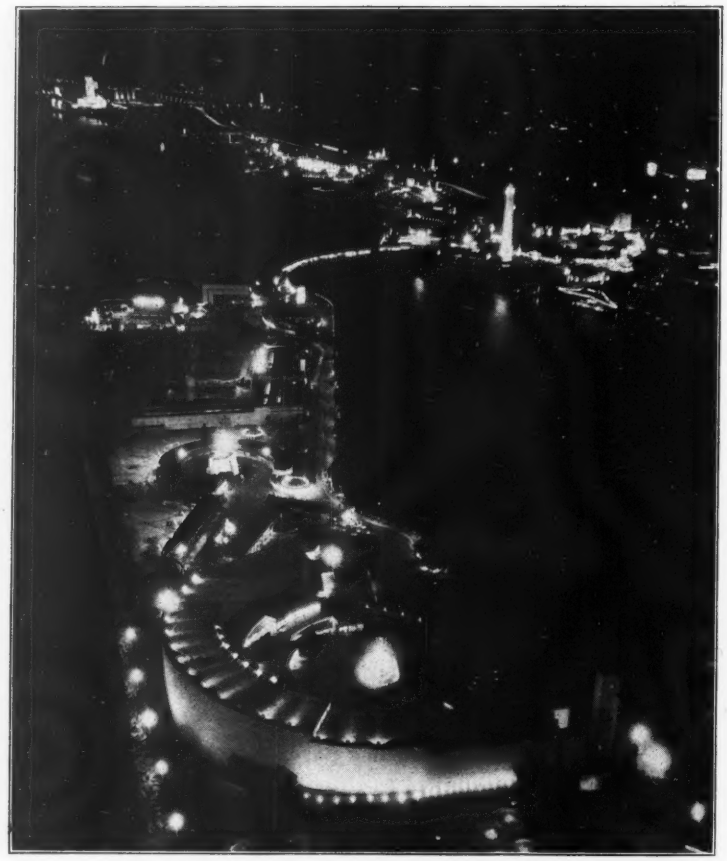
Third General Session

The third general session will be held at 8:40 p. m. the evening of Wednesday, June 6. Addresses at this session will be made by Floyd L. Carlisle, member of the Board of Trustees of the Institute, and Bernard F. Weadock of the Institute. Mr. Weadock's address will be a discussion of holding companies.

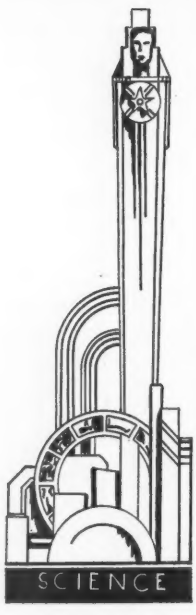
Fourth General Session

The fourth and concluding general session will begin at 10 a. m. Thursday, June 7, with a paper "Progressive Engineering Pays Its Way," by Philip Sporn, vice-president, American Gas and Electric Company, New York. Discussion of Mr. Sporn's paper will follow its presentation. J. L. Hecht, Public Service Company of Northern Illinois, Chicago, will have as his subject "Adjusting Operations to Present Trends." F. A. Newton, The Commonwealth and Southern Corporation, New York, will present a discussion on "Commodity Prices" and their relation to costs of production of electricity. At this session Frank W. Smith, chairman of the Prize Awards Committee, will announce the winners of the several prize awards administered by the Institute. Presentation of the awards will be made at the same time. The awards include the Charles A. Coffin Award; the H. M. Byllesby Prizes; the Forbes Prize; the A. L. Lindemann Prizes, the James H. McGraw Prizes; the Thomas W. Martin Award, and the George A. Hughes Award. On this occasion also the first presentations of the new Edison Electric Institute Medal for resuscitation by the Prone Pressure Method will be made.

The 1934



A view from the Skyride at the 1933 Century of Progress exposition



IN NEW AND attractive dress, with striking and important changes in its physical layout and with many new features of interest, A Century of Progress Exposition which proved so successful and which exerted so profound an influence in 1933, reopens its gates to the world this year. It promises to be in every way a more spectacular and interesting exposition than its 1933 predecessor which attracted nearly 22,500,000 visitors. Improvements which have resulted from the experience of the previous year's operation and knowledge regarding the public's reaction will make it a more effective and smoothly functioning spectacle.

In general, the most interesting and desirable features of last year's exposition have been retained, while those which proved not so desirable have been eliminated and new ones substituted. The major changes that have been made are along what was last year known as the Midway. Nearly all of the amusement concessions in this section have been removed and transferred to a place along the lake on Northerly Island and the space occupied by them given over to a group of new foreign villages. Towards the south end of the Midway, too, the new Ford building is located, a notable addition to the automotive group. The Skyride remains as last year but the lagoon below it this year is marked by a spectacular new fountain—the most startling thing of the entire exposition. With few exceptions nearly all of the important manufacturers who exhibited last year are again exhibiting this year.

Science Again Principal Feature

So much for the general features of the Fair. In presenting this article on the 1934 exposition here, it is not our purpose to describe the Fair in detail, nor even to cover the whole thing generally; rather we will consider those aspects which are of more especial interest to the engineer and scientist. Last year it will be recalled the keynote of the exposition was the progress through science during the last hundred years. This theme, expressed generally throughout the entire exposition was centered in the Hall of Science.

This year, "science" again occupies the center of the stage, so to speak, but instead of being concerned so much with the accomplishments of the past, the idea this year will be to show that this idea of progress through science is continuous, that it is going on today at as rapid a pace as ever, and that even since the 1933 exposition many new developments and discoveries have been made. These new discoveries, it will be shown, may have no application at the present time but from the basis of past experience in which equally apparently useless discoveries have turned out to be of immense value, may be of great future importance. Indeed, since last year's exposition a number of new and amazing scientific discoveries have been made of which the layman knows very little but which it will be the endeavor of this year's exposition to direct to his attention. For example, this year we have "heavy" water, or rather water in which the hydrogen component is composed largely of the newly discovered heavy isotope of hydrogen. The atomic weight of ordinary hydrogen it is well known is 1.008, whereas the atomic weight of this new hydrogen is 2. Just now, of course, we have no par-

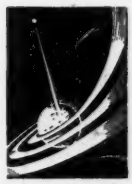
4 CENTURY *of* PROGRESS EXPOSITION

ticular use for either this kind of hydrogen or water, except as the heavy atomic nucleus may be used as a projectile in atomic disintegration studies. Regardless of its present unimportance in the practical world, an attempt will be made at the Fair to show what this heavy hydrogen is.

As another example of scientific development this last year, may be cited the work done in cosmic ray research and the stratosphere flight of Settle and Fourdney. To the public at large, the stratosphere flights are regarded as stunts and their interest centers purely on the spectacular and exciting aspects. But these flights, particularly the last flight by Settle and Fourdney, have disclosed an immense amount of important data, particularly as regards cosmic rays. Insofar as possible, the nature of these discoveries and the apparatus by which they were made will be shown. The gondola of the Settle-Fourdney flight will not be shown but the instruments and the results obtained will be on display.

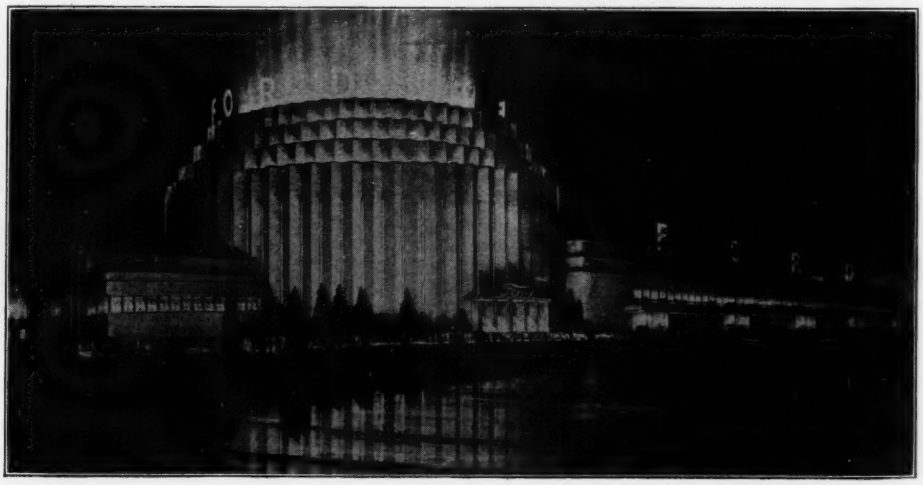
These are typical examples of the type of new things that will be displayed this year in the Hall of Science. In some instances the display will be limited to an explanation of basic principles. In "television" for example, considerable work has been done during the year but it involves such complexity and refinement of equipment that it is impractical to demonstrate it continuously to large audiences. In this case, therefore, only the fundamental principles involved will be shown. These, of course, center largely upon the principle of the photo-electric cell and an attempt will be made to show them as clearly and interestingly as possible.

In all this, as already explained, the idea will be to show that developments such as these are continually in progress and that their apparent unimportance today is no criterion of their ultimate value.



In general, the exhibits in the Hall of Science will follow closely along the lines of those last year but with improvements and additions. Those of the readers who were fortunate enough to be able to visit the Century of Progress last year no doubt were impressed by the beautiful and cleverly displayed mathematical string models of Dr. Pollock. This year a completely new set of Dr. Pollock's models are to be seen, including a number of simplified models and illustrations of the everyday application of the principles. Also in the mathematical section are shown models illustrating the fourth dimension and the theory of relativity. Visualization methods will be used to make these theories comprehensible and to show their practical bearings.

Those particularly mechanically inclined will find considerable of interest in a new group of exhibits designed to show the fallacy of perpetual motion. Down through history men have dreamed of perpetual motion machines and hundreds of thousands of inventors have struggled with this idea which today, from modern science, we know is impossible of realization. But regardless of that fact, perpetual motion inventors are perennial and each year brings a new and enthusiastic crop. It is probably not with any serious idea of discouraging these inventors that these exhibits are presented but it is of interest to see actual models of some of the most famous perpetual motion machines in action—but in this case



THE NEW FORD BUILDING

A conception by Hugh Ferriss. This building is 900 ft. long and 10 stories in height in its central section. It will require 6000 kw. for power and light. A torch of light one mile high is projected upward from the central court by a battery of 36-in. searchlights with a rating of 30,000,000 candlepower

FOURTH DIMENSION

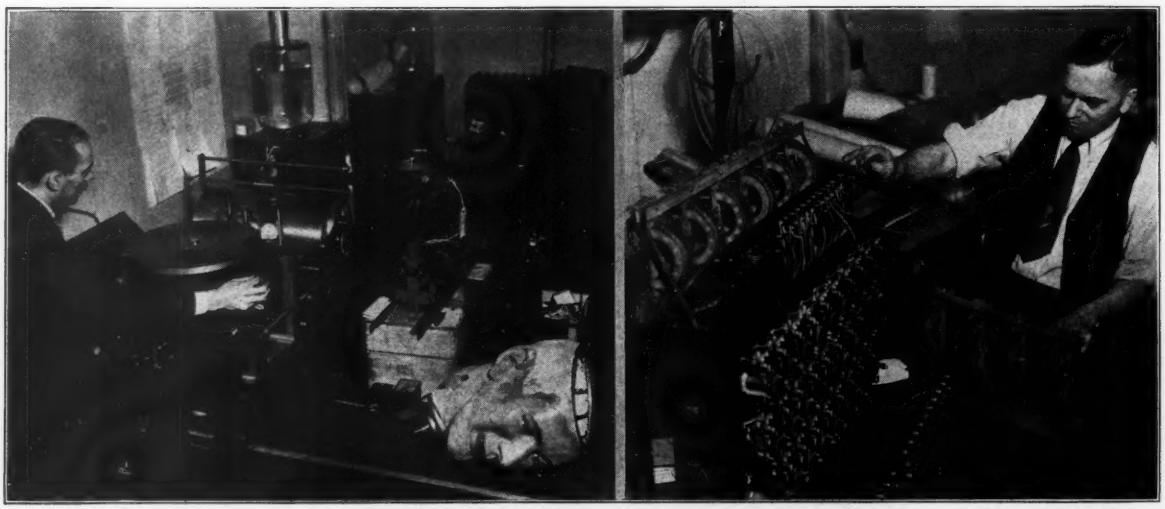
Dr. Saul Pollock in charge of the Mathematical Exhibits with his models (left) of a system of Universes and (right) of the fourth dimension. The model at the left involved $2500 in its construction

the *action* is invariably due to an outside source of power. In each case at the beginning of the demonstration the source of power will be concealed and then, accompanied by suitable explanatory captions or directions from a loud speaker, the source will be exposed to view and the power cut off. Thus the machines will stop, exposing the fallacy of their design. Several types of such machines will be shown, beginning with early models, purely mechanical and carrying the idea up to more modern forms involving electrical circuits. This exhibit is presented as a part of the mathematical section. Another new exhibit in this section will be one showing the theory of logarithms and the principle of the slide rule. This will involve a large mechanically operated slide rule which will perform simple operations as they are explained by an accompanying loud speaker.

In the physics section this year, there is shown a remarkable electrical device known as the Hodoscope, an instrument for observing and studying the individual cosmic rays by making their paths visible. This is an ingenious, intricate apparatus which is shown to the public for the first time this year. The paths of the cosmic rays are seen as rows of flashing lights controlled by sensitive cells, those cells being activated by the cosmic rays themselves. The effect is that of actually seeing the continuous paths of the rays.

In the biological division, important changes have been made. The Micro-Vivarium developed by Dr. George Rommert showing on a number of screens enlargements of the actual living things in drops of water which was so popular last year has been doubled in size and placed in a more prominent position.

These few examples merely serve to indicate the character of the changes which have been made in the Hall of Science but it must not be assumed that this



THE MAKING OF A ROBOT

By the use of a new plastic material which will stretch to conform to facial movements the face of the robot in the Hall of Science this year becomes very lifelike. At the right the nerve center of the robot is shown under construction. At the left is shown the sound reproducing equipment which coordinates his speech with facial movements

description is complete or even partially so. Throughout the entire building all the moving exhibits and demonstrations have been re-studied and re-designed as a result of the experience of their showing last year. The "industrial type" of basic science exhibits have undergone corresponding improvements. The "Story of Air" for example, exhibited through the sponsorship of Union Carbide and Carbon Corp., has been enlarged and the liquid air theatre on the main floor will be continued on an improved basis. The same is true of the exhibits in the medical section which have been greatly extended.

Scientific Theatre

An entirely new feature in connection with the Hall of Science this year is a continuous outdoor scientific theatre held in the court of the Hall of Science. This great new feature of the Exposition has been worked out by the scientific staff as a major addition to the educational exhibits. Ten thousand spectators at a time may view the seeming miracles being performed on the stage. Performances start around noon and continue until 10 or 11 p.m. each day. The different acts are from 20 to 25 min. long. At the time of this writing final arrangements had not all been completed but among other things a complete radio station will be wheeled on the stage with operators who will communicate with other stations in various parts of the country and possibly in other countries. Communications will be both by international Morse code and by voice, in the case of the former an attempt will be made to translate the signals as they are received for the benefit of the audience. This demonstration has been developed for the show by the World's Fair Radio Amateur Council.

Another "act" in this theatre will be a complete demonstration of how the light from the star Arcturus was used to light up the exposition last year. Last year the light was picked up at one or several large observatories throughout the country and the electrical impulse so initiated transmitted to the exposition. This year the telescope picking up the light together with all photoelectric and amplifying equipment as well as the relays and switches controlling the lights will be placed on the stage in full view of the audience. Instead of lighting the entire exposition this year, however, the impulse will light the "Arcturus Beacon" a tall pillar bearing a decorative beacon light which will be a great torch of gas.

In addition to these acts there will be a mathematical show, a demonstration by Western Union of "teletype," a recital on the "color" organ, a demonstration by Elgin Watch showing the determination of "time" and a demonstration of electronic music.

These acts which are designed largely to "amaze" the non-scientific are all of a sound scientific basis, and are supplied largely by the laboratories and research staffs of important industrial organizations exhibiting at the Fair.

Electrical Building

So much for the pure science exhibits. In general, the various industrial exhibits follow closely along the lines of last year's exposition. Both General Electric and Westinghouse together with Western Union and

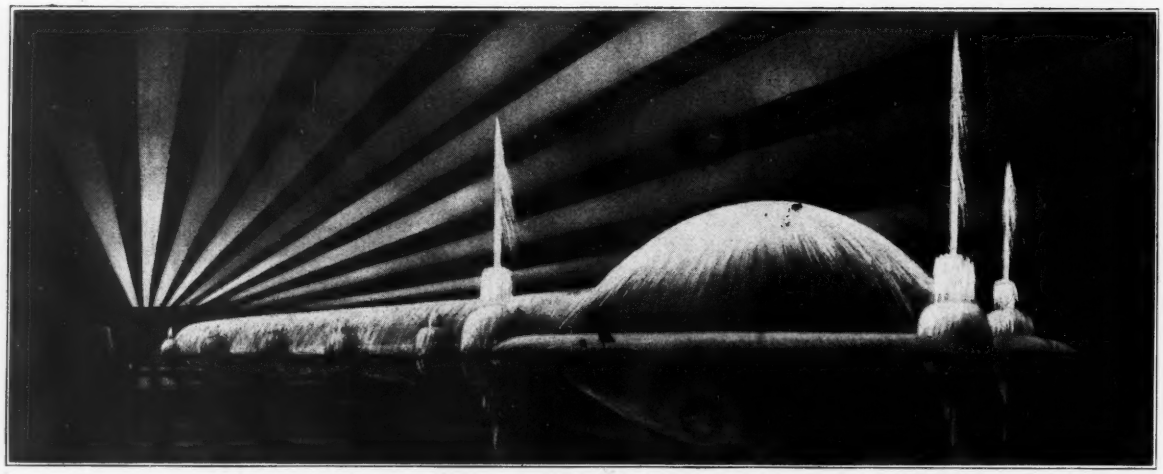
THE COSMIC RAY HODOSCOPE

By means of this remarkable apparatus cosmic rays are seen as rows of flashing lights controlled by sensitive cells, those being activated by the cosmic rays themselves. The volume of this instrument within which the rays are visible is 10x9x4 in. Through this volume may be seen the paths of 30 rays per min.

R.C.A. are the chief exhibitors in the Electrical Building. The American Telephone and Telegraph Co. this year, however, is not exhibiting; the space which they occupied last year being given over the Western Union and to a display of development in television.

General Electric this year presents an entirely new "House of Magic" based largely upon researches which have been made since the last exposition. One of the interesting "stunts" will be to "shoot on" the lights instead of shooting them out as in the old wild west days. A full sized gun that shoots bullets of light will be used. Instead of the customary cartridge, a small incandescent lamp with a concentrated filament is built into the gun. A pull on the trigger flashes a short but intense beam of light from the barrel of the gun which registers a hit on a photoelectric target when the operator's aim is good.

Demonstrations with ultra violet light and with radio active materials will form another part of the show. In quite another field will be shown the mechanics of non-resonant gears. Carrying the scientific demonstration idea farther than last year, General Electric introduces a new method of displaying its products. In each section of the exhibit which will become a series of demonstration rooms with moderate seating capacity, lecturers will demonstrate some experiment



WORLD'S LARGEST FOUNTAIN

This huge bank of water, two city blocks long and having a flow great enough to service a city of 1,000,000, will have lighting effects in five colors and a giant "aurora borealis" of 40 great searchlights above it

in pure science which was the forerunner of the modern electrical device.

Westinghouse this year also has made many important changes in their exhibit, chief of which perhaps is the "Little Theater of the Home." This theater with its revolving stage is scheduled to present 30 shows daily. Its entire action depicting the "electrifying" of a home takes place in 11 min. The cast, consisting of one actress portrays all the human action guided by voice and music provided by sound equipment. Six complete scenes are shown.

Another new feature of this exhibit will be a 300-hp. quick stopping motor. This motor which was developed for use in a rubber mill can be brought from full speed to dead stop in less than one second. It will be arranged so that visitors can start it by pushing one button and stop it by pushing a second button. This 300-hp. motor is the largest revolving machine in the exhibit which the visitor can play with.

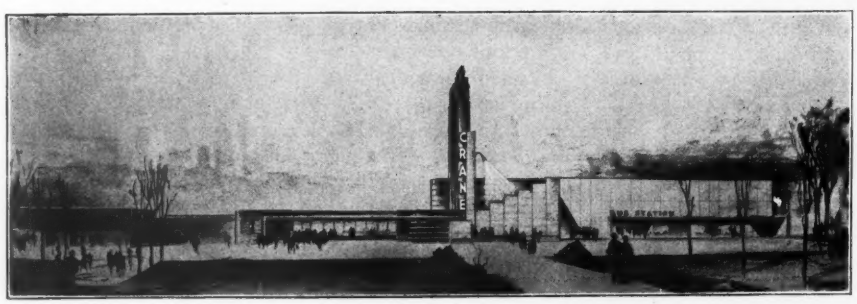
To show development in switching, there will be shown an armored glass case within which are placed two circuit breakers, one an ordinary carbon type and the other in the new deion type. By pushing a button, the visitor can throw a short circuit of 1000 hp. on the breakers in succession. The public no doubt will find considerable more interest in the spectacular burst of flame at the opening of the carbon breaker than in the more modern deion breaker with scarcely a perceptible spark. To supply this exhibit a 300-kw. motor generator set will be kept running.

As was the case last year with the Westinghouse exhibit, research developments will be shown on the mezzanine floor. Here there will be shown the latest developments in researches—in radio, X-rays, lighting, photocells, new types of instruments and measuring equipment, advances in production of materials, etc.

In addition to the great 90 ft. diorama showing the generation, transmission and utilization of electric power, which featured the Central Station Committee exhibit last year, this year this exhibit will include a marionette show depicting the uses of electricity.

New Ford Building Has Load of 6000-kw.

Among the new industrial exhibitors at the Century of Progress exposition this year, the most important is the Ford Motor Co. The Ford Building, 900 ft. long by 213 ft. wide and terminating at the south end in a circular court 204 ft. in diameter, will require a load of 6000-kw. or more than a third of the total electric capacity of the entire World's Fair in 1933. More than 9000 floodlights all concealed in the building structure itself and ranging from 100 to 500 watts each are required for the night lighting. Perhaps the most spectacular feature of the Ford exhibit, however, will be the torch of light, 200 ft. broad at its base, which will spring from the parapet of the open court at the end of the building. This shaft of light will involve some 30,000,000 candle power, the result of the concentration of 24 thirty-six inch projector searchlights. Under proper atmospheric con-



THE NEW CRANE BLDG.

Designed primarily to indicate the importance of valves and fittings, this building will be of interest to the general public because of the extensive use of photo-murals

ditions, this torch of light will rise to a height of one mile.

One of the interesting features of the exhibition section which will be divided among the various divisions of the Ford Motor Co. and 21 exhibitors who are large suppliers of Ford will be the use for the first time of high pressure mercury tubes which emit light predominating in greens and blues. Intermingled with the high pressure mercury lamps will be Mazda lamps which predominate in reds and yellows. The combination of both of these units will give "day" light.

The exhibits in the Ford building will show in actual operation practically all of the steps required in Ford manufacturing from the raw materials to the finished parts for cars. Among the exhibits will be a 250-kv-a. foundry, a welding exhibition using two 350-kv-a. welders and 300 kv-a. in small welders, a steel rolling mill with a 100-hp. motor and a miniature tire factory using two 100-hp. motors.

General Motors and Chrysler are also introducing many new interesting features this year. The General Motors exhibit this year will include an air cooled scientific laboratory, showing how new features in the automotive industry are developed in the laboratory. The great general reception room of this building also will be air cooled. Another feature of this exhibit will be a fluorescent fountain.

Crane Co. this year occupies the new Crane Building at 28th Street instead of the Electrical Building where it was located last year. Designed primarily to indicate the importance of valves and fittings, this exhibit has been made interesting to the general public by the extensive use of photo murals.

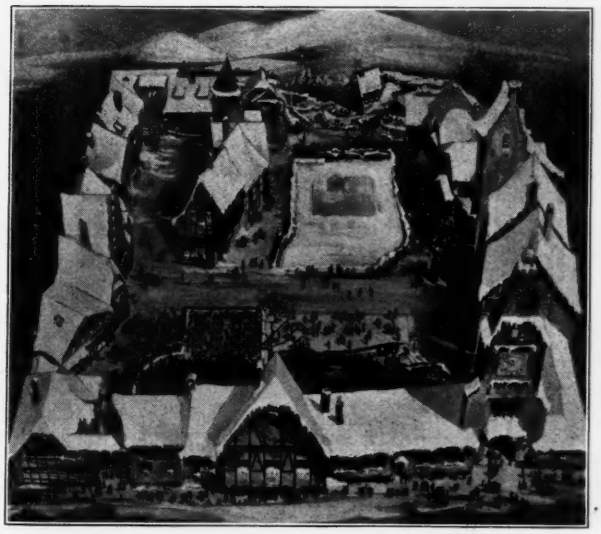
New Foreign Villages

An important addition to the 1934 World's Fair will be a series of foreign villages in addition to those of last year. These new attractions will include the Swiss Village, the English Village, a German Mountain Village to be called the Black Forest Village, an old Spanish Village and Tunisian Village of Northern Africa to be known as the "Land of the Bedouins." These villages are constructed along the Midway which last year was given over to amusement concessions.

Ice Skating Pond in Hot Sun

The Black Forest Village is of particular interest not only because of its picturesque character but because of its unusual refrigerating features. For it was the aim of the designers not only to simulate the old world atmosphere of a German mountain village, but also the very climate—cool, healthful and exhilarating. So it is planned to provide in the buildings and restaurant of this village a temperature and relative humidity corresponding to the summer climate of the Black Forest Hills. The requirements for this air conditioning are to be met by a carbon dioxide refrigerating system designed and built by the Wittenmeier Machinery Co. of Chicago.

Even more difficult and exacting are the refrigerating requirements for maintaining a natural ice skating rink in the open under the boiling hot summer sun. Not only must this ice, which will often be exposed to the direct action of the hot summer sun under temperature conditions exceeding 100 deg., remain ice, but it must remain sufficiently hard for exhibition skating. This refrigeration is also being met by a direct expansion CO_2 system. The skating rink has an area of 1600 ft. and will be served by a separate 40-t. compressor.



AN ICE POND UNDER THE HOT SUMMER SUN

The Black Forest Village will be of exceptional interest because of the ice skating rink which will be maintained in the open under the hot summer sun.

670-ft. Electric Fountain

Among the new features of general interest at the exposition this year, the most spectacular will be a great electric fountain—the largest and most beautiful ever built. Starting from the center of the 12th St. bridge that connects the mainland with Northerly Island, this brilliantly lighted bank of water will extend south 670 ft. into North Lagoon. It will require 68,000 gal. of water per min., enough to service a city of 1,000,000 population. This is nearly five times the capacity of the present largest fountain.

Magnificent lighting effects in five colors, green, red, amber, blue and white will make the spectacle unlike anything else in the world. Starting from the base of the bridge, the fountain shaped like a huge tunnel will stretch 570 ft. to a dome of water 40 ft. high and 200 ft. wide. Three single high sprays will throw water 75 ft. into the air. The total lighting load for this fountain will be equivalent to that of an average city of 150,000 persons. The ten pumps which total 2500 hp. will draw water from North Lagoon. This fountain is the really big single feature of the 1934 Century of Progress Exposition.

While these many changes make this 1934 World's Fair quite different from last year's, it must be emphasized that the essential spirit of A Century of Progress has been preserved. The theme and purpose is essentially the same and the exhibits will tell the story of industry's indebtedness to science in much the same way as last year.

POWER PLANT ENGINEERING June 1934

Fundamentals of Power Plant Piping Design

Part III. In this last article of the series, the author points to increasing use of higher pressures and temperatures, the place welded piping is taking in design and the welding fittings that are becoming standard practice

By

Henry C. Moffett*

IT IS USUALLY found that higher steam pressures in power plants require more complicated piping designs. This is true in most cases because of the necessity of using many more pieces of auxiliary equipment, such as heaters, water purifiers or evaporators and intermediate pumps. It is also true because of the increased temperature of the steam to be conveyed, necessitating extra bends for expansion and contraction and additional hangers and anchors for holding the lines in place. The larger the plant, the more refinements are allowed, such as weighing tanks for testing, and duplicate headers and branches for important units.

When pressures were 250 lb. per sq. in. or below, systems were comparatively simple, and the piping problems were never very troublesome. There was ample room for all equipment and connecting piping in practically every case and crowded galleries were unheard of. Today, however, when nearly all new plants are employing 400 lb. per sq. in. and up to 1350 lb., and a few have gone to even higher pressures, the piping problems are far from simple; in fact some of the most difficult features of design are found in the piping layouts.

Materials Must Stand High Pressures and Temperatures

As pressures increase, the search for better materials goes on. Search for metals to withstand higher pressures and temperatures has been unceasing, for designers have been obliged to find new ways to accomplish the desired results. Better designs have been required and better steels and alloys have been developed and manufactured. Construction methods have been given a great deal of study. These improvements have come about for many reasons, one being that managers and power superintendents have become aware of the importance of power piping, and have become open minded, seeking improvements themselves and allowing ample time to secure these better piping jobs. Trouble in the past from leaky and vibrating pipe lines, together with frequent shut-downs on account of failures and needed repairs, has been educational, and is now reflected in a spirit of coöperation with engineers and manufacturers.

Many unique developments have resulted from this demand for better designs and safer materials. Along with improved designs has come an unexpected economy, because it has been learned that when sufficient study is given piping problems, costs are made lower. The advice of men who have devoted their lives to such problems is now being sought, and their recommendations followed. Manufacturers and metallurgists are working hand in hand, codes have been developed which standardize the materials as to quality and dimensions. Scientists have contributed their part by solving the difficult problems of stress and strain in hollow bent tubes when expanded by heat and pressure. It is a tribute to the trade as a whole that today pressures of 1000 lb. per sq. in., and temperatures of 1000 deg. F. can be safely handled by the use of special alloys.

Welded Joints Now Strong as Pipe

For many years, all those interested in power piping for steam plants, both from the standpoint of design and from an operating standpoint, have been watching the development of welding as applied to such systems. It was recognized long ago that welding would simplify piping design and construction, but up until the last few years a welded pipe joint was looked upon with suspicion, especially if the weld was made in the field. This was because the weld was not made by any controlled method, as the art of making such connections was not as fully perfected as it is today. It is now possible to make, by improved methods of welding and the use of better welding rods, a connection which is as strong as the pipe itself, and in many cases stronger. It is still true, however, that only expert welders, and by that is meant men who have had shop training and apprenticeship, should attempt to weld a joint for pressure piping.

In addition to the better welding rod available and to the higher standard of welders on call, there has been another advance in the art in the past 3 or 4 yr. This advance has been in the kind of members which are to be welded together to form the piping systems, other than the pieces of straight pipe. There are now a number of manufacturing concerns who produce fabricated pieces of special form especially for welding, up to and including the 600 lb. standard, and one or more who have produced special shapes for a plant operating at 900 lb. per sq. in. at 750 deg. F.

These special shapes or welding fittings are made as tees, elbows, nipples, caps, sleeves, welding neck flanges and the like. They are either made from seam-

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less steel tubes or are forged from billets of special steel, the composition of which corresponds to the composition of the latest A. S. T. M. specification for seamless pipe. Some of them have extra thicknesses of wall where the severest stresses would occur in a fitting. Some are formed by special process so that the wall thickness is the same on the outside of a bent portion as on the inside. All are machine bevelled at 45 deg. with a ⅛-in. normal land, and practically all of them are of full inside diameter or bore corresponding to the straight pipe size.

Other manufacturers have developed special types of bends with long tangents, especially for welding, the claim being that their use eliminates a number of otherwise necessary welds, and that the higher stresses can be made to take place at points near the bends and not in the welds. Several bends may be made in one length of pipe, in one or more planes. For ordinary thicknesses and sizes of tubing lengths of 40 ft. are obtainable, and for larger sizes or very thick pipes, lengths are limited only by the size of billet obtainable. For example, 12-in. pipe of 1 in. wall thickness can usually be secured in lengths up to 26 ft.

Besides the special forms that can be regularly obtained from fabricators or from stock, many special forms can be made in the field by good welders, using stock tubing. Steam separators and drip pockets can be made on the job, swages executed to reduce the size of pipe in a run without the use of flanges or special fittings, and orange peel bull plugs made to blank off a header or main.

There are many distinct advantages to a modern welded job. Only a few flanges are necessary, such as are required at equipment inlets or outlets, at important valves or at such points in the lines as may have to be opened up for inspection periodically. Minor valves may have welding ends instead of screwed or flanged connections. The design is therefore greatly simplified, even though it may be fundamentally the same as would be required for a flanged construction. With welded connections it is possible to make closer connections, especially on a manifold or multi-branch header. It is easier to design for clearances. A great advantage is the fact that time is saved because it is not necessary to wait for special shapes and castings to be made and shipped. Those lines which must be covered with insulation are covered more easily and economically, because there are fewer flanges in the way.

Design Must Allow for Expansion

All designs for piping to convey steam or other heated fluids must be made with the expansion of the pipe in mind. Elaborate methods are sometimes used to determine the magnitude of the forces and the resultant bending moments and stresses. A few of the better manufacturers making welding specials, have gone into this phase of design quite thoroughly and have prepared a number of bulletins containing design data and charts for the use of designers. These are valuable aids, and should be used to the fullest extent by all who for the first time attempt to lay out a welded system of piping of any importance.

The weld in pipe work is part added metal and part metal from the pipes themselves adjacent to the welding rod that is worked into place by the use of the torch. The rod is an important item and should always be of the highest quality. If the weld is properly made, and the rod used of the best grade, the weld often will have a tensile strength approaching 60,000 lb. per sq. in. Some new methods of welding make use of inert gases to shield the work while being done, the result of which is a weld free from oxidation and scale.

It is highly important to have the ends of the pipe to be welded absolutely clean. Dirt or other foreign matter will always cause trouble, and may form pin holes in the weld so small that they show up only on test.

Besides the welding of the pressure parts of a piping system, there are many other places where welding is of advantage. Lugs may be fastened to headers to form limit blocks in guides. Members may be welded to pipes for anchor attachments or for brace rods. Pipe hangers may be lengthened or shortened or brackets welded together from structural shapes.

Creased Bends

Other developments have been adapted to welded systems, such as corrugated and creased pipes. These new items have come into prominence of late because by their use smaller radius bends may be fabricated, which, when properly incorporated in expansion U-bends or other common expansion type bends, will greatly increase the flexibility of the members and take up much less room. Aside from these advantages, larger pipes may be bent to small radii for use in crowded quarters such as in steam turbine installations, or on board ship. These special bends are formed from seamless tubing by special processes. Full information as to the use of these new bends and the amount of expansion that may be taken care of by them, may be had from the fabricating companies.

A very good paper entitled "Frictional Resistance and Flexibility of Seamless-Tube Fittings Used in Pipe Welding", by Crocker & McCutchan is published by the A. S. M. E., under the index FSP-53-17. This paper compares the flexibility of 90 deg. turns whose ratios of center line diameter to pipe diameter, range from 0 to 6, and give methods of determining the bending moments at fixed ends as well as stresses at the curved portions of the bends. The authors conclude that welded piping, built up of seamless-tube fittings and pipes compares favorably with other types of construction as to appearance, pressure drop and flexibility.

Gas as Boiler Fuel Is Advancing In Use

By some inexplainable mixup in transcribing from the original source of the data to the printed page, an error appears under the title given above in the January 1934 issue to which attention has just been called. The first paragraph, second column, page 61 should have the figures changed to read as follows: Excess air required for the combustion of gas is low compared with other fuels used in power plants, ranging in practice from 8 to 25 per cent with an average of 13. This is equivalent to a flue gas analysis range of 11 to 9½ per cent CO_2 with an average of 10.

Know Your Lamp Voltage

Comparatively small variations in lighting system voltage from normal cause wide variations in lamp life or in efficiency. It is therefore essential to maintain the system voltage as near to that for which the various lamps are designed as possible

INCANDESCENT LAMPS are peculiarly sensitive to relatively small variations in voltage, more so than many other power using devices. For this reason it is desirable to know and to maintain the voltage of a lighting system as nearly normal and constant as possible. Even slight variations one way or another from normal voltage may greatly increase lamp costs or result in poor efficiency of illumination.

In the April issue of the General Electric Review, Dr. W. E. Forsythe of the Lamp Development Laboratory of the General Electric Co. discusses the variation in lamp characteristics due to change in voltage and presents data showing the variation and characteristics resulting from relatively small changes in voltages. This discussion is based on a study of the characteristics of a number of three representative sizes of 115 v. gas filled incandescent lamps (the 40 watt, the 100 watt and the 500 watt lamp). Since all three of these lamps are in wide use in industrial plant lighting systems, this data should be of interest to plant engineers generally.

This study involved the measurement of temperature, current, luminous output and the calculation of lamp life. The temperature of the central turns of the different segments of the filaments of lamps were measured with a disappearing-filament optical pyrometer. In all cases such measurements were made at the maximum temperatures obtained under test operating conditions. The temperatures given are for the scale that has been in use in the Nela Laboratories for several years. On this scale the melting point of gold is taken as 1336 deg. K.* The average industrial plant engineer of course is interested most vitally in the lamp life and the efficiency of illumination, that is the number of lumens per watt. The other data contained in the accompanying table, however, is also of interest.

In two of these lamps the filaments are normally mounted in inside frosted bulbs. For the measurement of temperatures, therefore, the filaments in these lamps were mounted in clear glass bulbs and a correction was made for the absorption of the glass so that the temperatures given are the actual true temperatures of the hottest part of the filament. The lumen outputs of the lamp at different voltages were measured by the testing section at Nela Park. The values of the life for the different voltages were calculated, using the latest so-called constants that show how the life changes with a change in voltage or efficiency that have been obtained from the testing sections' accumulative data on the life characteristics of these lamps. To make such calculations the various characteristics were expressed as an exponential relation of the voltages or the efficiencies and the value of the exponent used that corresponded to the particular condition of operation. Thus for instance, the relation may be written.

$$L = KV^{-d} = K_2E^{-b}$$

where L is the life in hours, V the voltage, E the efficiency in lumens per watt, K and K_2 constants d and b so-called constant exponents. By measuring the life and efficiency of the various lamps at different voltages, the value of the so-called constants d and b have been determined for a wide range of voltages. In general, such exponents vary with the lamp size and the applied voltage. The exponent b varies from about 6.8 for 40-watt gas-filled lamps to about 7.5 for the 500-watt gas-filled lamps. The variation of this exponent with voltage is about 3 units in the second decimal place for a 5-volt change for a 40-watt 115-volt lamp, and about 2 units in the first decimal place for a 5-volt change for a 500-watt 115-volt lamp. The exponent d changes from about 15.4 for a 40-watt lamp to about 12.8 for a 500-watt lamp. The voltage variation for

TABLE I. VARIATION OF LAMP CHARACTERISTICS WITH VOLTAGE

	Volts				
Lamp	105	110	115	120	125
40-watt					
Current (amp.) ..	0.333	0.341	0.348	0.356	0.364
Temperature (deg. K.)	2607	2655	2702	2748	2793
Lumens per watt.	8.76	9.77	10.80	11.86	12.96
Per cent watts...	87.5	93.8	100	106.6	113.7
Per cent lumens..	70.8	84.8	100	117.4	136.4
Per cent life.....	418	200	100	52.5	28.5
100-watt					
Current (amp.) ..	0.830	0.850	0.870	0.890	0.910
Temperature (deg. K.)	2732	2779	2825	2870	2914
Lumens per watt.	12.39	13.64	14.90	16.17	17.46
Per cent watts...	87.1	93.5	100	106.8	113.
Per cent lumens..	72.5	85.6	100	115.8	133.4
Per cent life.....	373	189	100	55	31
500-watt					
Current (amp.) ..	4.135	4.245	4.345	4.450	4.550
Temperature (deg. K.)	2835	2886	2936	2985	3032
Lumens per watt.	16.57	17.99	19.4	20.82	22.22
Per cent watts...	86.9	93.4	100	106.8	113.8
Per cent lumens..	74.1	86.5	100	114.6	130.0
Per cent life.....	328	178	100	58	35

*Centigrade absolute scale, known as Kelvin.

this exponent is about —3 units in the first decimal place for a 5-volt change for a 40-watt lamp and about —2 units in the first decimal place for a 5-volt change in the 500-watt lamp. Knowing the value of these and other exponents and how they vary with different operating conditions, the change in the more important characteristics with a change in the voltage can be calculated.

The characteristics for the 40-watt, 100-watt and 500-watt gas-filled lamps that have been obtained are shown in the table. The Bureau of Standards has from time to time published equations that show how certain lamp characteristics vary with the voltage. The values that were obtained for these characteristics of the three lamps checked with corresponding values given by the Bureau of Standards to within the limits of accuracy for the measurements.

It will be noted from the accompanying table that the characteristics of all these lamps are based on the 115-volt rating. At 115-volt the life of the 40-watt lamp is 100 per cent. Raising this voltage only 5-volts to 120 decreases the percentage of life to 52½ per cent, whereas raising the voltage 10 volts to 125, results in a lamp life of only 28½ per cent. On the other hand, decreasing the voltage to 105-volt, that is lowering the voltage by 10, gives a lamp life of 418 per cent but at the same time it will be noted that the lumens per watt decrease from 10.8 to 8.7 per cent. This will serve to show how greatly the life and efficiency of a lamp varies with change in voltage.

In considering the life of an incandescent lamp, we are of course dealing with average lives. It is impossible to make every lamp live exactly the life for which it is designed, but the average of a considerable number will give life results close to their rating.

There are many factors which affect the life of a lamp. One, to illustrate the difficulties met, is uniformity of filament diameter. If there were a thin spot in the filament and if the diameter at this thin spot were only 1 per cent less than that of the rest of the filament, this spot would get so much hotter that the lamp would live only one-third as long as it would without the thin spot. When it is recalled that for some lamps it would require as many as four filaments laid side by side to equal the diameter of a human hair, it will be appreciated that a tremendous degree of accuracy of filament diameter is required to have a high degree of uniformity of lamp life.

REFRIGERATION Machine CAPACITY and OPERATION

By
W. E. ZIEBER
York Ice Machine Corp.

Requests for a practical discussion of compressor capacity have been numerous and this article written by Mr. Zeiber for the N. A. P. R. E. is a practical and useful answer

THERE ARE several essential parts which are the same in any refrigeration system, whether it is a household or 1000 t. refrigerating machine. Each must have an evaporator with a source of heat to boil off the refrigerant. There must be a condenser where the gas is condensed to a liquid which is used in the evaporator. This heat can be removed by either air or water. There must be a compressor or pressure increasing device whether it be jet, reciprocating or centrifugal. A means for driving this compressor must be provided from any kind of power available. If it is an absorption system, the compressor is replaced by an aqua pump and a generator.

The evaporator must be designed so that it will operate at the suction pressure and tonnage that the compressor produces to which it is connected. If we know the heat transfer of a piece of equipment, the mean temperature difference at which it works and how many square feet of surface is in it, we can calculate the tons of refrigeration it will produce. From the temperature of the medium being cooled, we can determine the suction pressure and the compressor must produce the required tonage at the evaporator suction pressure.

From Table I it is possible to determine how many cubic inches of ammonia gas must be handled per minute per ton of refrigeration by the compressor. These figures have been used in actual practice for many years. This table also shows the indicated horsepower per ton required by the compressor.

Friction horsepower, which is 10 to 15 per cent of the indicated horsepower, must be added to obtain the actual motor horsepower required.

Suppose a plant contained an evaporator, either brine cooler or coils of any kind, which would produce 14 deg. F. brine and 100 t. refrigeration with 4 deg. F. ammonia evaporating temperature or 14 deg. F. brine and 50 t. of refrigeration with 9 deg. F. ammonia evaporating temperature.

From ammonia tables one can find the suction pressure corresponding to 4 and 9 deg. F. ammonia to be about 18.8 and 23 lb. respectively. From Table I the size machine required to produce 100 t. with 4 deg. F. ammonia and 50 t. with 9 deg. F. ammonia in the evaporator can be calculated, then if there were a number of machines in the plant it would be possible to select those that would balance the evaporator.

If the machine does not balance the evaporator at the suction pressures named, its tonnage can be found

TABLE I. DISPLACEMENT AND I. HP. PER TON OF REFRIGERATION FOR YORK S. A. AND D. A. POPPET VALVE COMPRESSOR OPERATING ON DRY COMPRESSION AND DRY SUCTION GAS WITH LIQUID NOT SUBCOOLED. CIRCLES INDICATE THE A. S. R. E. STANDARD TON CONDITIONS.

Condenser Gauge Press. and Corresponding Temp. = Temp. of Liquid at Expansion Valve		SUCTION GAUGE PRESSURE AND CORRESPONDING TEMPERATURES																																		Cond. Press. ¶ G.
		5 lbs. = −17.2° F.			10 lbs. = −6.4° F.			15.7 lbs. = 0° F			20 lbs. = 8.5° F.			25 lbs. = 11.3° F.			30 lbs. = 16.6° F.			35 lbs. = 21.4° F.			40 lbs. = 25.6° F.			45 lbs. = 30.0° F.			60 lbs. = 33.6° F.						
		Volumetric Efficiency % of Displacement	Cu. In. Displacement per min. per ton of Ref.	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)	Volumetric Efficiency	Cubic Inch Displacement	I. H. P. per ton (Compressor)				
85 lbs. = 55.9° F.	S. A.	84.95	11110	1.15	86.4	8800	.963	89.9	6910	.789	90.9	6020	.677	91.7	5250	.579	92.3	4640	.484	92.6	4170	.407	92.9	3790	.378	93.2	3478	.317	93.3	3210	.988				85#
	D. A.	73.15	12900	1.31	76.2	9980	1.096	79.1	7850	.872	80.5	6800	.743	82.7	5920	.633	84.2	5080	.55	87 9	4390	.449	89.6	3950	378	90.6	3570	.923	90.8	3300	.229				
105 lbs. = 65.9° F.	S. A.	83.25	11600	1.30	85.0	9150	1.09	88.3	7200	.91	89.2	6280	.80	90.1	5460	.605	90.9	4820	.6	91.2	4340	.515	91.6	3920	.468	92.0	3595	.414	92.3	3320	.378				105#
	D. A.	71.5	13500	1.50	74.6	10420	1.25	77.5	8200	1.02	78.9	7100	.89	80.7	6100	.76	82.8	5290	66	85.85	4600	.57	87 5	4110	.49	88.2	3750	.422	88.5	3460	.385				
125 lbs. = 74.7° F.	S. A.	81.45	12100	1.47	83.6	9500	1.25	86.5	7500	1.06	87.9	6500	.933	88.9	5630	.82	89.4	5000	72	89.8	4500	.63	90.3	4070	.58	90.7	3700	.52	91.1	3430	.467				125#
	D. A.	70.0	14080	1.71	73.2	10850	1.43	75.9	8350	1.195	77.6	7360	1.033	79.7	6300	.915	81.6	5480	.8	84.8	4750	.695	86.1	4270	.61	86.55	3900	.54	87 3	3580	.49				
145 lbs. = 82.5° F.	S. A.	79.7	12908	1.654	82.5	9811	1.40	84.5	7829	1.195	86.0	6765	1.065	87.6	5836	.943	88.6	5139	.844	89.9	4610	75	90.3	4195	.691	89.6	3830	.68	89.9	3530	.58				145#
	D. A.	68.6	14645	1.921	71.6	11300	1 61	74 4	8901	1.338	76.3	7925	1.2	78 4	6922	1.054	80.3	5671	.932	83.7	4900	.82	84.7	4420	.73	84.9	4050	.65	86.0	3700	.59				
											19.6 lbs. = 5° F																								
154.6 lbs. = 86° F.	S. A.	79.1	12827	1.744	81.8	9980	1.48	83.8	7961	1.258	85.6	6933	1.15	86.95	6932	1.007	88.0	6223	.908	88.3	4685	.805	88.7	4260	.742	89.0	3885	.67	89.3	3600	.63				154.6
	D. A.	67.9	14928	2.029	70 9	12510	1.707	73.65	9063	1.444	76.6	7845	1.30	77.7	6637	1.127	79 7	6770	1.000	82.78	6000	.83	85.75	4510	.785	84.1	4125	.705	85.2	3770	.648				
165 lbs. = 89.7° F.	S. A.	78.4	13045	1.834	81.1	10148	1.56	83.15	8092	1.341	84.7	6990	1.201	86.3	6027	1.071	87.4	5307	.965	87.7	4780	.86	88.1	4325	.792	88.4	3950	.72	88.7	3650	.68				165#
	D. A.	67.25	15203	2.157	70.2	11720	1.802	72.9	9224	1 529	74.95	7898	1.357	77.0	6751	1.2	79.1	5868	1.067	81.85	5100	.94	82.8	4600	.84	83.25	4200	.76	84.3	3840	.70				
185 lbs. = 96.3° F.	S. A.	77.1	13401	2.013	79.8	10487	1.72	81.8	8362	1.487	83.4	7219	1.336	85.0	6223	1.107	86.0	5478	1.083	86.4	4900	.98	86.8	4450	.902	87.2	4080	.822	87.6	3760	.765				
	D. A.	65.9	15774	2.354	68.85	12150	1.993	71.6	9555	1.7	73.7	8176	1.513	75.7	6985	1.344	77.6	6068	1.202	80.35	5280	1.07	81.3	4750	.97	81.7	4350	.88	82.5	3990	.81				185#
205 lbs. = 102.3° F.	S. A.	75.8	13947	2.192	78.5	10834	1.879	80.5	8630	1.631	82.1	7450	1.47	83.7	6420	1.323	84.7	5650	1.203	85.1	5050	1.10	85.5	4600	1.024	85.9	4200	.924	86.4	3870	.86				
	D. A.	64.5	16362	2.571	67.6	12590	2.184	70.2	9890	1.87	72.3	8459	1.67	74.3	7222	1.488	76.3	6271	1.335	79.5	5420	1.19	80.2	4900	1.08	80.25	4500	.98	81.3	4110	.905				205#
225 lbs. = 108.0° F.	S. A.	74.2	14450	2.35	77.0	11200	2.05	79.2	8900	1.785	80.6	7700	1.62	82.4	6620	1.47	83.9	5780	1.33	84.2	5200	1.21	84.5	4720	1.12	84.9	4300	1.02	85.2	3980	.95				
	D. A.	63.2	16971	2 79	66.4	13000	2.385	69.05	10200	2.04	71.35	8700	1.84	73.7	7400	1.64	75.55	6420	1.47	77.9	5610	1.32	78.55	5080	1.21	78.8	4650	1.1	79.6	4200	1.02				225#
245 lbs. = 113.3° F.	S. A.	73.0	14900	2.52	76.1	11500	2.2	77.7	9200	1.93	79.2	7950	1.76	81.3	6900	1.60	83.1	5920	1.45	83.3	5340	1.32	83.6	4840	1.23	85.9	4420	1.12	84.1	4090	1.05				
	D. A.	62.2	17500	3.00	65.05	13450	2.56	67.95	10520	2.2	69.95	9000	1.99	71.95	7680	1.78	74.55	6600	1.6	75.9	5840	1.45	77.2	5240	1.33	77.55	4800	1.22	77.95	4410	1.15				245#

by taking a proportional difference between the brine and ammonia. Suppose the balance suction pressure was 8 deg. F. ammonia instead of 9 deg. F., then the tonnage would be $(14 - 8) \div (14 - 9)$ or $(6 \div 5) \times 50$ or 60 t. refrigeration. In other words, the tonnage of an evaporator is proportional to the difference between the ammonia and average brine temperatures.

From this you can see that when you have the rating of an evaporator for any brine temperature and suction pressure, you can check the tonnage it produces. Use suction pressure and condensing pressure under which it operates to check the tonnage of the

TABLE II. THEORETICAL COMPRESSOR DISCHARGE TEMPERATURES FOR DIFFERENT CONDITIONS. FOR EACH 10 DEG. F. HIGHER SUCTION TEMPERATURES THAN SHOWN ADD 15 DEG. F. TO DISCHARGE TEMPERATURES.

Condenser Pressures and Corresponding Temperatures	Discharge Temperatures for Various Operating Pressures Ammonia Compression — Suction Gage Pressure and Corresponding Temperatures														
	0° G. = -28° F.	2.5° G. = -22.3° F.	5° G. = -17.2° F.	7.5° G. = -12.65° F.	10° G. = -8.4° F.	12.5° G. = -4.55° F.	15.7° G. = 0° F.	17.5° G. = 2.35° F.	20° G. = 5.5° F.	22.5° G. = 8.5° F.	25° G. = 11.3° F.	27.5° G. = 14.0° F.	30° G. = 16.6° F.	35° G. = 21.4° F.	40° G. = 25.8° F.
105° G. = 65.9° F.	240	225	210	200	189	183	172	167	160	154	149	142	138	131	123
115° G. = 70.4° F.	253	238	223	213	202	195	184	179	172	165	160	154	149	141	134
125° G. = 74.65° F.	265	251	235	225	214	206	195	190	183	176	171	165	160	151	144
135° G. = 78.7° F.	277	262	246	236	225	217	205	200	193	186	181	175	170	161	154
145° G. = 82.55° F.	288	273	256	246	235	227	214	210	203	196	191	184	180	170	163
155° G. = 86.15° F.	298	283	266	256	244	237	224	219	212	205	200	193	189	179	171
165° G. = 89.65° F.	308	293	276	266	254	246	233	228	221	214	209	202	198	188	179
175° G. = 93.05° F.	318	303	286	275	263	255	242	237	230	222	217	210	206	196	187
185° G. = 96.25° F.	328	312	295	284	272	264	251	246	238	230	225	218	214	204	195
195° G. = 99.35° F.	336	321	304	292	280	272	259	254	246	238	233	226	221	212	203
205° G. = 102.3° F.	345	329	312	300	288	280	267	261	254	246	241	234	228	219	210
215° G. = 105.2° F.	354	337	320	308	295	288	274	269	261	254	248	241	235	226	217
225° G. = 108.0° F.	361	345	328	316	303	295	281	276	268	261	255	247	242	233	224

compressor according to Table I. Machine tonnage is thus obtained to use as a meter.

If the machine is to be used as a meter it must be in good running order and without any liquid entering the cylinders. Besides making them fit for meters in this shape, they produce the most tonnage for the power expended. This means it must have properly adjusted bearings and keep the friction of the stuffing box to a minimum. The suction strainer must be kept clean or it will reduce the pressure in the compressor cylinders below that in the suction line and cut down its capacity. Suction strainers have been clogged, not only by dirt, but by oil freezing in the line returning from the evaporating system. Leaky bypass valves affect the capacity of a compressor and heat the suction gas sufficiently to cause leaky discharge valves and scored cylinders.

Piston rings, suction valves, and discharge valves should be inspected and put in proper shape at regular intervals because they can cause drop in capacity, higher horsepower per ton and also affect the lubrication of the machine, sometimes causing scored cylinders. The temperature of gas discharged from a compressor, whether too high or low, indicates the condition of that compressor. Table II shows the theoretical discharge temperature for ammonia compressors when operated under the conditions shown. If there is excessive super heat at the suction inlet to machine, examine the by-pass valve for leaks. This will affect the discharge temperature. If the by-pass valve or the suction inlet temperature are not causing the high discharge temperature then it is the internal parts of the machine. When the gas discharge temperature is low it is an indication that liquid is entering the cylinders. The speed of machine and type of valves affect the discharge temperature. Comparing the normal discharge temperature of the machine, when valves are in good condition and speed nominal, with the above table will show a temperature difference that should not be excelled to any great extent.

The stems and guides on the valves must not be loose, otherwise they will not seat properly. The water from the compressor jacket should leave at no less than 100 deg. F. for economy and best efficiency on the cylinder walls. The ammonia gages should be tested on a dead weight tester at least once or twice a year.

A compressor at a constant speed will produce more refrigerating tonnage at a high suction pressure than a low one. If a compressor with 700,000 cu. in. per min. displacement is operated at a suction pressure that required 10,000 cu. in. per min. per t. of refrigeration, it will produce 70 t. If this machine operates at a suction pressure that requires 5000 cu. in. per min. per t. of refrigeration, it will produce 140 t. Of course, you must have sufficient evaporating surface to operate at the higher suction pressure but there are very many times when the lighter loads in a plant would allow a small compressor to be operated on the entire evaporating system at a high suction pressure, whereas the operators use large compressors at low suction pressures. This latter condition means a large difference in power cost as shown by Table I.

Increasing suction pressure 1 lb. gage reduces the power consumption approximately 1 kw-hr. per t. of ice made per day. Increasing suction pressure 1 lb. increases machine capacity about three per cent.

How Shall DIESEL LINERS Be Finished?

Survey of Manufacturers Gives Little Information Upon Which to Judge Relative Merits of Bored, Ground or Honed Liners

SINCE THE INTRODUCTION of large precision grinders, the question of proper shop methods of finishing Diesel engine cylinder liners has been a more or less controversial subject. Judging from the number of companies using the different methods, boring, as the first method in use and a method that has given satisfaction, is the most popular. The following reply expresses this opinion:

"We have, up to the present, been boring our cylinders with a spring tool, but our pistons are invariably ground to size. Piston rings are left with a turning tool finish, which allows them to seat very quickly to the cylinder bore. We, too, have investigated the experiences with ground cylinders, but reports have not been favorable among manufacturers to whom we have broached this subject. Grinding of large cylinders requires the installation of extremely heavy grinding equipment, and in our opinion, no grinder that is now on the market will grind a cylinder as accurately as we can bore it for any length of time. By this we mean that the ordinary wear in a grinding machine will result in inaccuracies far greater than are allowable."

Size Is Important

This question of relative size is mentioned by a number of manufacturers and is probably in the end the deciding factor. Apparently difficulties of maintaining tolerances with the larger grinders place a limit on the cylinder size that can be handled this way. Perhaps the most thorough investigation of the relative methods is reflected by the following opinion which limits ground cylinder sizes to below 20 in. diameter.

"Our practice is to bore the cylinder liners fairly smooth and we do not recommend Diesel engine cylinders of 20 in. and over to be ground. Due to the experience that we have had, we find that by finishing the bores fairly smooth, there is a sufficient amount of pores left in the liner for maintaining the oil film in breaking in the engine. Following this practice, we find that after a week's run, the liners have taken a perfect glaze without undue wear on the piston rings.

Practice Changes

"It was the writer's conclusion, after investigating all the Diesel engine builders in Europe 6 yr. ago, that their practice was to leave the bore in the cylin-

der liners rather rough just in order to maintain a better lubrication while breaking in the engine. Some 9 yr. ago, it was the common practice in Europe to grind the liners and the pistons, but this has all been eliminated by every large Diesel builder both in this country and abroad."

Some companies, of which the following is an example, use both methods, the dividing line again being cylinder size:

"In our various plants we use different methods of finishing cylinders without any reference to the superiority of honed or ground cylinders over bored cylinders.

"At one plant we build very large engines. There are perhaps no grinding machines in the world large enough to finish these bores. The work is finished with single tool cutters, but this requires highly skilled men who stay with the company during their entire working life if some standard of finish and appearance is to be maintained. In other plants we make thousands of smaller cylinders yearly. There is no possibility of producing a uniform product by the individual efforts of the number of men employed and we have a greater labor turnover on these machines.

"We at first attempted to use sized cutter heads in finishing the cylinders, but the up-keep, that is, shimming them out to size and regrinding to keep bores within tolerances, proved to be so great that some other means had to be adopted. No grinding machines of sufficient size were available in this country at the time. We imported one from Germany and later bought others in this country when they were produced here. On these machines the quality of finish was determined entirely by the wheel quality so long as the machine spindles were kept in good order by tool makers.

"We have also used some honed cylinders. This is a very nice finish, but as the stones are not very free cutting, heating results and great care and much expenditure of time is required if the bore is to be reasonably accurate when the cylinder cools down. You will understand that a 16-in. cylinder expands 0.001 in. for every 10 deg. of temperature.

"We still have the fondness felt by most old builders for bored cylinders and at the same time are quite proud of our ground cylinders and equipment for producing them. We have not been able to determine any difference in performance whatsoever."

Not all companies agree with this one that there is no difference between the various methods. For instance,

"Our Diesel engines are equipped with ground pistons and cylinder liners. We believe that by using this method of finishing pistons and liners we can obtain closer clearances and the engine will wear in more quickly than engines not finished in this manner. Also, grinding does not have the tendency to distort the piston and liner as boring does.

"Some engineers argue against grinding and base their arguments on the belief that the grinder particles work their way into the iron being ground and later work loose, causing damage to the piston and liner. They also state that the lubricating oil cannot sink into the parts as quickly as it does on bored pistons and liners. We have tried both methods of finishing our cylinders and liners over a period of years and we find that grinding increases the life of the engine by reducing wear."

One company considers both grinding and boring obsolete and has turned to honing as the best finish obtainable:

"Our company has in the past employed both methods of finishing cylinder liners but some time ago both were discontinued and it is our practice to finish these liners by honing which offers the following advantages: We have found honing enables the shop to obtain better finish and closer tolerance than any other method; in our two-cycle engine it is especially necessary that proper finish be obtained over the port bridges and this is done much more accurately by the honing process; honing gives more exact dimensions and a smoother and more even surface to the cylinder liner which results in a better running in of the cylinder and piston on the test floor and in better performance from the start after the engines are installed in the field."

Another angle, the economic one, brought up by present manufacturing methods, is discussed in the following paragraph by two builders, one from each side:

"While ground or honed surfaces would naturally result into a lowering of the friction coefficient and a somewhat retarded wear of the liner and piston rings at the very beginning, it has been our experience, however, that our bored liners made of our special iron mixture, take a high polish after a short time of operation. Our cylinder wear is very satisfactory, and it is for this reason that we do not feel justified in purchasing special grinding equipment for finishing large and long bores and also in exposing the cylinder surfaces to the possibility of developing hair cracks when grinding."

"With reference to the relative merits of ground or bored cylinder liners for Diesel engines, we are not able to pass our opinion since we have never used anything but ground cylinders. Our production facilities are such that grinding coördinates best and we have, therefore, continued this practice from the beginning of our manufacture of Diesels. We have never seen any reason to change from this practice and, consequently, we are not in a position to give you any expression of our opinion of the two methods. We have obtained satisfactory service from the ground cylinders."

It is obvious that as far as actual data are concerned, advantages of the various methods from the user's standpoint will be substantiated, and the controversy, if justified, will be settled, only, by the operators themselves as indicated by at least one of the prominent manufacturers:

"For some time we have used bored cylinder liners, particularly for our large engines, and we also use ground cylinder liners for our smaller high speed engines. We are not in a position to make a comparison of the advantages of either, we do not feel that we have had enough time to make comparisons, and too, the operators of the engines are better qualified to draw a comparison than the engine builder."

Considering the replies as a whole, no reasons or supporting data are brought forth to indicate the superiority of any one of the three methods of finishing. Apparently all three give satisfactory service, the determining factor being shop conditions, cost of machinery, mechanical construction and precedent.

Readers' Conference

Emergency Foundation Bolt

In looking over the April issue of Power Plant Engineering, I note on page 198, the item by Charles H. Willey. I have used a simpler bolt which I think gives better service, and can be made in a few minutes by any unskilled man. No hole is drilled in the foundation bolt and only one hacksaw cut is made across the bolt.

For a two-inch diameter bolt, the tapered pin will weigh several pounds and trouble will be found in holding the tapered pin in the bolt end when the bolt is reversed, whether the hacksaw cut is single or double, as Mr. Willey suggests.

To overcome this defect I made several teethlike depressions with an ordinary file on the narrow end and on the two sides of the tapered pin. Such file teeth hold the pin in place when it is lightly tapped into place and the bolt can be reversed while a pin so filed and tapped into place will not fall out of the hacksaw cut. Otherwise the bolt is used as Mr. Willey describes. The tapered pin can be made from a piece of square iron and the pin should be no wider than the diameter of the bolt. It is obvious that any diameter of bolt can be treated, also the hacksaw cut should be made quite long, especially so in emergency bolts of comparatively large diameter.

Toronto, Ont. James E. Noble.

Water Hammer in Steam Pipes

Referring to the article under the above title by F. Paul in the April number of Power Plant Engineering, the reason why the pipe sagged is quite evident from the drawing—if the supporting truss is built as indicated in the drawing.

No doubt many readers of Power Plant Engineering know enough about the mechanics of roof trusses to see at a glance the thing that is wrong, namely, a member is missing from the inside area which is bounded by four lines. Whenever you see a truss of this kind which is not broken up into triangles, you can generally be certain that the truss is going to sag, and that's exactly what happened in this instance.

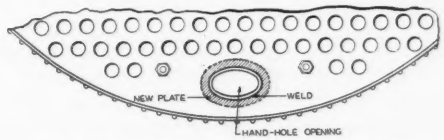
I do not recall the exact wording that is applied to conditions of this kind, but if my memory is correct, two of the joints are what is known as "unbalanced."

Newark, N. J. W. F. Schaphorst.

Repair for Damaged Hand-hole Opening

When a horizontal return tubular type boiler has been in service for a considerable time, trouble often occurs with the hand-hole opening in the rear head below the tubes. Leakage of the gasket together with the corrosive action of the flue gases in the presence of moisture, use of scale scraping tools through the opening, and ash erosion thin the metal edges down to the breaking point and a tight gasket seat is no longer possible.

Following is a method of repair which is approved by most boiler inspection departments. The boiler is emptied after cooling and the hand-hole plate is removed. The damaged metal, as shown in the shaded section of the sketch, is cut away preferably with an air chisel. An elliptical piece of boiler plate of a thickness not exceeding that of the rear tube sheet nor not less than ¾ of that thickness is cut so that it will overlap the new enlarged hand-hole opening by



NEW SEAT FOR HAND-HOLE PLATE

not less than ½ in. An elliptical hole of the same form and dimensions of the original hand-hole is cut in this piece of boiler plate. It may be burned with a torch to a smaller size and finished with an air chisel.

This piece is then put inside the boiler and held in place against the inside of the tube sheet. The seam around the cut out section of the tube sheet is welded tight. With this new plate installed the hand-hole may be replaced with a new and safe gasket surface. Care must be taken to have the gasket bearing surface smooth and in a flat plane. If not in this condition it should be so prepared before being installed.

Boston, Mass. Harry M. Spring, Jr.

Study in Gears

Water-wheel speed control was more or less of a farce several years ago. As a matter of fact, there are plants in operation to-day whose water-wheel governing is nothing to boast about. The early type governor simply picked teeth on a ratchet wheel—forward or back, as the fly-ball mechanism dictated—and took several seconds to open or close the gates.

As time went on, the overshot and undershot wheel became a thing of the past. More efficient machinery came in. Some of the old school ask if the modern turbine can be more efficient than the overshot. A certain weight of water was turned into a certain horsepower with extremely small losses.

The object of this article is not to argue efficiencies of water-wheels but to defend a water-wheel governor whose action was very disappointing.

A certain small company purchased (sight unseen), a new governor from a local machine shop; the machine shop being the agent, not the maker. The governor was erected, with quarter-turn drive and gate operating gearing (see Fig. 1). But the fluctuation in

speed prohibited good production. The gate was never at rest; it was opening or closing continually. The company positively refused to accept the machine.

This governor was purely mechanical, but so designed that a pilot controlled the main operation. Supposedly, the gate could be opened or closed in two and one-half seconds.

One of the workmen was a country boy who had, as yet, no knowledge of machinery. He was an apprentice. He swept the floor and learned the operation of the lathes and milling machines at spare moments. But he ventured to suggest (against all rules of propriety) that the unbalanced condition of the gate made too great a burden on the governor. In other words, the gate tried to open and the governor had to reverse to prevent it. Likewise, the gate, at certain opening, attempted to close and the governor had to combat the action.

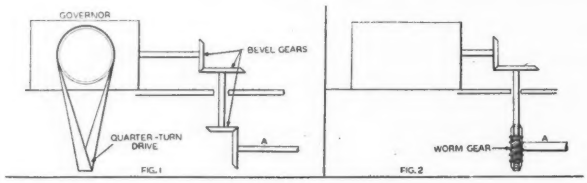


FIG. 1. GOVERNOR GEARS THAT GAVE TROUBLE
FIG. 2. REPLACING BEVEL GEARS WITH WORM GEAR CORRECTED DIFFICULTY

That was exactly the situation. The problem was not solved in an instant, but took much time and study. But at considerable expense and changing of the control gears, one shaft being moved to one side several inches, the final train contained (Fig. 2) a worm assembly.

This combination took all of the unbalanced hazard away from the governor. Where the gate stopped, it remained until a change in speed required a new position.

If the same mechanism were used to-day, in the handling of cylindrical gates, greater satisfaction would obtain, I feel sure.

Lawrence, Mass. TOM THUMB.

The Point of View

TO THE ENGINEER who has served long years in a foul smelling engine room, apprentice and operator, the college bred specie is a prig.

On the other hand, the boy who has faithfully attended college, foregoing many pleasures and burning much midnight oil seldom gives due consideration to the opinions of the self-taught specimen.

It is my aim, in this article, to show that—at least, in some cases—neither has a right to cast reflections, on the other.

It wasn't so many years ago that the steam engine indicator was more or less of a mystery to the average operating engineer. Many a turbine engineer today, if shown a card that was a bit off-color would be flabbergasted.

Then again, the CO_2 analyzer or Orsat, was a mystery, and is still today in some circles, as is the slip-stick; yet the college boy can turn them both inside out.

But the old dog of the power plant has to tell the college boy who is making the official tests, that the first baffle is down in number six.

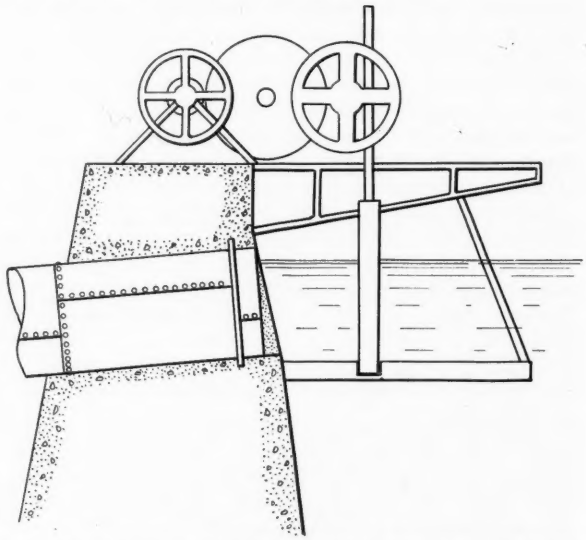
To illustrate and cite two cases:

A small mill in the country owned by a New Yorker of some prominence had steam and water power as prime movers. The water power was sufficient, in wet weather, to operate the mill, but the storage was limited.

The owner imported another New Yorker, who was an engineer of some note, to tell the mill engineer how to make the water last longer so that fuel might be saved.

Being a good clean scout, the owner thought a lot of his country engineer, but he thought a lot more of the judgment of a technical man whose bill would be one-twenty-five per day and expenses.

The New York expert made a careful and lengthy investigation, covering—without any loafing—two full weeks. At the end of his survey, he submitted a 25 page report, estimating and quoting bids.



INTAKE SHOWING HOW LOWERING BED OF RESERVOIR WOULD NOT INCREASE USABLE STORAGE CAPACITY

He had found that the reservoir, supplying the water for the wheels, had a mean depth of only 9 ft. It was possible, the bottom of the reservoir being soft, to dredge to an estimated depth of 20 ft. The cost was, of course, a bit high but the owner was worth a bundle of kale.

Before the expert engineer went home to New York, the owner—as a courtesy, to the country cousin—suggested that he (country) glance the report through and offer(?) corrections.

"May I ask questions, too?" he inquired.

"Sure. Ask all you want. My friend can answer anything that you can think of, I'm sure," the owner smilingly replied.

"You know, or perhaps you don't know, that we can only draw the level 4 ft. After that, our flume is getting out of the water. You don't, by any chance, intend to pump that extra 'leven feet, do yuh?" That was the only question necessary.

In all fairness to the New York expert, he acknowledged—as the country folk say—the corn.

It would look as if the country engineer won the first round.

The Second Case:

A very serious wreck occurred in a large cotton mill because the engineer in charge didn't know (no one had ever told him) that the low pressure cylinder was not as strong as the high pressure.

If a college man was called upon to do something, out of the ordinary channel, he would analyze the problem, do some figuring and go ahead.

But, the self-taught engineer disconnected the high pressure side of the unit, shut off the steam, opened the low pressure connection to the high pressure steam line—and went ahead.

That there was no loss of life was proof of the fact that, "God takes care of the feeble minded."

The cylinder was split from end to end. On the supposition that a 72-in. cylinder was as strong as a 36-in. (neglecting the difference in thickness of plate), this engineer cost his company thousands of dollars in repairs and loss of power.

This round did not go to the self-taught engineer.

Perhaps it is admissible that the college graduate and the self-taught engineer each has his little niche, in the hall of fame, and that a sudden shock or jar may knock either or both to earth; depending on the point of view.

Lawrence, Mass. C. J. WILDER.

Furnace Protection for Induced Draft Failure

WITH BOILER furnaces which are equipped with forced and induced draft fans and which burn fuel in suspension, a possibility exists of a furnace explosion if the induced draft fan should stop while the forced draft and fuel feed continue. Several special interlocks and arrangements are in general use which minimize this possibility.

In plants not protected by such a system it is well to consider the installation of some such protective device. The accompanying sketch shows a powdered coal fired furnace using both forced and induced draft. A simple but effective protective method is also shown in the sketch. A 1¼ in. pipe passes through the furnace wall by an inspection door. This prevents any likelihood of the end of the pipe becoming covered with slag. This pipe passes through the base of a cast-iron chamber and extends upwards about 4 in. from the inside of the base. This chamber is half full of light engine oil. An inverted, copper bucket floats on the surface of the oil with the 1¼-in. pipe termination inside of the bucket. The top head of the cast-iron chamber is vented to the atmosphere. This head is also fitted with a central bushing having a 5/8-in. hole through it. A copper rod, securely soldered to the top center of the bucket passes through this hole. This rod operates a contactor arm. The contactor points are open as long as the bucket is in normal position.

Should the furnace pressure rise to a positive pressure considerably above atmospheric pressure the bucket will be forced upwards closing the contacts. Such an abnormal rise in furnace pressure can only be caused by failure of the induced draft fan or its control, with the possible exception of slight flare-

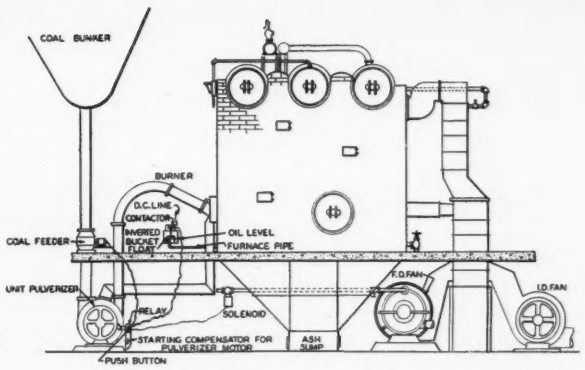


DIAGRAM OF DEVICE TO PROTECT FURNACE FROM EXCESSIVE PRESSURE

backs when starting up. When these contacts close they cause a relay to operate which in turn causes the pulverizer motor compensator to trip the motor off and also a quick closing solenoid valve on the forced draft fan turbine line and the coal feeder motor control. In case of automatic vane control of the forced draft fan this relay may cause the vanes to close giving even more rapid reduction of the forced draft.

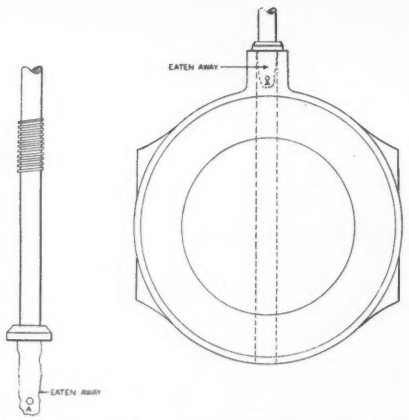
On the side of the relay box is a push-button which when held in causes the contactor circuit to be open. This push-button is pressed while the burners are lighted so that a momentary flareback will not cause the relay to function. The control should be tested every time the plant is shut down by raising the bucket float rod manually until the contactor closes. It may also be tested by starting the forced draft fan slowly with the induced draft fan shut down (while the boiler is down) until the relay operates. The last method is seldom necessary or desirable due to the probability of dirt being blown out into the air ports or boiler room. Maintenance should consist of keeping the oil level correct, the furnace pipe clear and the contact points clean.

Boston, Mass. HARRY M. SPRING, JR.

Rusted Valve Stem Causes Boiler Outage

ILLUSTRATED HERE are the stem and gate of a rising stem gate valve, on a feed line to one of two 485-hp. water tube boilers that went out of commission one morning, shutting the feedwater off entirely from one of them. Something had to be done in a hurry. Another valve was located in the feed line between the defective valve and the boiler, so the pump was shut down, the valve next to the boiler closed, bonnet removed from the defective valve and the gate pulled out with a hook. The bonnet was then replaced and by watching the pump carefully and manipulating the feed valve to the other boiler the run was finished.

I found another valve of the same size and make so we used the stem and gate out of this for replacement parts. This valve was an old make and we were lucky to have another one like it. The sketch shows how the stem and gate were eaten away at the connection between them. This is a solid gate with a hole running through the center as indicated and had threads in the one end. The stem was screwed



VALVE STEM AND GATE SHOWING RUSTED CONNECTION

into the gate, as far as the collar and a pin was put through both stem and gate, A-A being holes for the pin. The pin was all that was holding stem and gate together after the corrosion got in its work and the pin sheared its way out through the end of the stem.

Superior, Wis. FRED S. RUTLEDGE.

Boiler Feed Pump Economy in Industrial Power Plants

WHERE THE industrial power plant heat balance includes turbine driven centrifugal or steam driven reciprocating boiler feed pumps exhausting to an open feedwater heater, it is often found that the exhaust steam from these and other steam driven auxiliary units is in excess of that required by the heater. While this condition may be the result of an improper balance between steam and electrically driven auxiliaries, a close check on economy of the pumping units will often reveal excessive steam consumption, with a consequent decrease in the overall thermal economy of the power plant.

Such a check is of especial value in those plants having provision for the use of exhaust or bled steam from the prime movers to supply any deficiency of auxiliary exhaust in the feedwater heating system. Under these conditions the absence of any visible waste from the heater relief valve often leads the engineer to assume the economy of the auxiliary equipment to be of no importance, as all of the auxiliary exhaust is utilized. This failure to consider the possibilities of increased use of steam from the prime movers by maintaining auxiliary equipment economy at its maximum point generally results in appreciable losses at the prime mover exhaust.

In the absence of permanent metering appliances on steam supply and exhaust lines to boiler feed pumps and other auxiliary equipment, periodical tests should be conducted to determine the steam consumption of these units. The information obtained from these tests, when compared with the manufacturers' steam rate curves and pump characteristic curves, will often reveal serious losses caused by defective mechanical condition of the equipment, indicating internal inspection for wear, adjustment or incrustation.

Among the principal causes of excessive steam consumption of boiler feeding equipment, other than defective mechanical condition, are the losses caused by improper operation. Some of the operating practices to be avoided, if maximum economy is to be secured, are the operation of pumps at other than their most efficient point under given load conditions; maintaining excessive pressures in boiler feed lines; scale formations in these lines which cause an excessive pressure drop; leakage from the discharge line to the suction line caused by leaky valves or check valves on idle pumps; carrying uneconomical back pressures on steam end of the units; improper adjustment of feedwater regulators, and other control devices causing extreme fluctuations in feedwater demand and poor control of steam admission valves on some types of turbine drives.

Waynesboro, Va. S. H. COLEMAN.

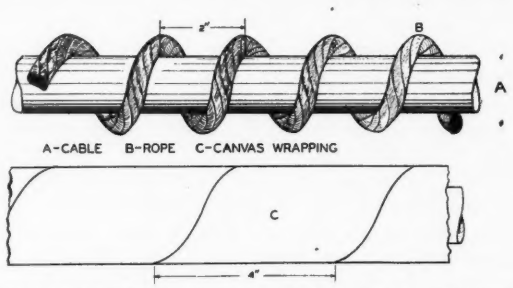
Protecting Cables

IN MANY cases where cables are unarmored additional protection is needed to protect them from mechanical injury.

Additional protection can be given in the following way. Get a length of ordinary rope say ½ in. in diameter and wind it round the cable as shown. The turns of the rope should not be touching, a convenient distance between turns being two inches.

The rope should then be painted with hot bitumastic paint so that it is completely impregnated, this will help to preserve it. Now get some strips of canvas over 4 in. wide and start to wind it over the rope as shown at C. When completely wound on, the canvas should be given a coat of hot bitumastic paint, this will serve the joint purpose of preserving the canvas and sticking it to the rope.

Where the canvas starts and finishes it should be



CABLE PROTECTED BY ROPE AND CANVAS WRAPPING.

tightly bound with twine and then painted. When the paint is dry the canvas will be securely joined to the rope and the cable will be surrounded by a wrapping of canvas. A cable treated in this way will be given a great amount of protection from mechanical injury, the weight of the cable will not be greatly increased, its flexibility will not be reduced, and this method of protection is cheap.

Herts, England. W. E. WARNER.

GREENHOUSES raising violets and azaleas are kept at a temperature from 40 to 45 deg. F.; carnations, 50 to 55 deg.; roses and mushrooms, 55 to 60 deg.; orchids, 60 to 65 deg., according to scientists of the research department of the Petroleum Heat and Power Co. For general purposes a temperature of 55 to 60 deg. is maintained, and for forcing, about 5 deg. higher.

New Equipment

Gun for Applying Graphite

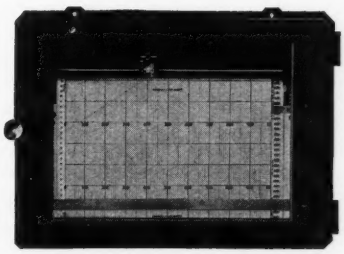
THROUGH a new invention in the form of a lubricating device marketed by the Joseph Dixon Crucible Co. of Jersey City, N. J., under the name of Graph-Air gun, Microfyne flake graphite, a silky lubricating powder may now be utilized for all-purpose lubricating service. The Graph-Air gun, being made of rubber, when squeezed, deposits the graphite where needed in measured amounts through positively controlled air pressure. The measured or graphite volume is largely con-

trolled by the position of nozzle in relation to the dial on top of gun. The nozzle may be turned to a complete shut-off position making the gun practical to carry in tool kits without spilling graphite.

A plug fitted to the bottom of the gun and easily snapped in and out, carries a disk of chamois for use as a burnisher.

Photoelectrically Balanced Recording Potentiometer

IN A NEW recording potentiometer recently developed by C. J. Tagliabue Mfg. Co. of Brooklyn, N. Y., a beam of light is reflected by a galvanometer upon a photocell which through a system of relays and moving shutters actuate



the balancing mechanism of the potentiometer. The action is quite ingenious; shutters intermittently operated in front of the cell, detect deflections of the light beam and synchronized electric contacts control the motion of a contact carriage to and fro across the chart and the slide wire of the potentiometer. In this way the potentiometer is electrically balanced and when the light beam is at the center of the shutters, the mechanism records the position of the carriage and turns a multiple switch to a new position. The photocell in this instrument is not a calibrated element but serves only to detect the direction of the light beam and bring the galvanometer to zero deflection by the so-called "null" method of balancing an electric circuit.

This instrument is supplied in a black enameled aluminum case for universal mounting, records from one to twelve temperatures, with any standard chart range and operates on 110 or 220 v. 60 cycle current. Thermocouples are supplied in iron; constantin, chromel, alumel, platinum, platinum-rhodium and copper constantin. It is said to have no critical adjustments and the slide wire is 90 per cent compensated for wear.

New Brown Electric Meter Body

THE BROWN INSTRUMENT CO. of Philadelphia announces a new meter body for electric flow meters. It is designed for measuring the flow of any liquid, vapor or gas creating a differential pressure across an orifice of 1.6 to 16 in. of mercury. The outstanding features of this meter body are ease of cleaning and range changing, combined with ruggedness and simplicity.

A seamless steel "U" tube with union compression fittings connects the high and low pressure chambers. A mercury drain mounted on this tube has a hardened needle point screw which seals the mercury drain hole in the "U" tube. Mercury cannot be blown out of this meter body under severe overload or reverse flow conditions. Two highly resilient seals of an oil resisting material, seat firmly in the high pressure chamber, one seal on top of the float, one underneath.

As the mercury level rises and falls with flow changes, the float in the high pressure chamber is free to move and accurately follows the

mercury level. Movement of the float is transmitted electrically to the indicating or recording meter by the inductance bridge principle, a patented feature of Brown electric flow meters.

Forged steel pressure chambers, heavy seamless steel tubing for the range tube—"U" tube—and piping, with all copper gasketed fittings recessed, eliminates welding. Rugged construction permits working pressures to 2500 lb. per sq. in.

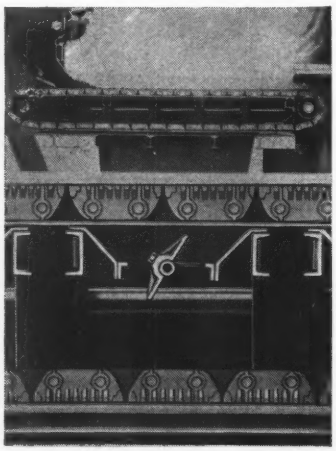
The base of the meter body is interchangeable for wall or floor mounting and made of malleable iron to stand shocks on severe applications. The range of this meter body can be changed without shutting down the line. Nine interchangeable range tubes with corresponding charts for the recording meter are available. An external pulsation check is designed for precision adjustments with the meter body under full line pressure.

Pire Insulating Refractory

CHICAGO FIRE BRICK Co., Chicago, Ill., has developed a new plastic insulating refractory which is to be marketed under the trade name Pire. This insulating plastic is adaptable for use in intermittent furnaces where actual operating temperatures do not exceed 2500 deg. F. The insulating properties, it is claimed by the manufacturer, reflect the heat, giving a flash heat to the walls in a short period of time. Pire is used in place of regular fire brick and has the faculty of being able to stand up under flame impingement. Because of its monolithic character heat loss by leakage is retarded. The material is light in weight, and has practically no coefficient of expansion.

Green Stoker Redesigned

COMBUSTION ENGINEERING Co., New York, N. Y., has substantially modified the design of its Green natural draft chain grate stoker, in order to provide for fixed attachment of controls, a frame construc-



tion capable of coping with expansion, and simple conversion to forced draft. Instead of a cast-iron frame supported on wheels, as formerly employed, the new design, designated as the "KS", has a stationary structure, fixed into the setting. This consists of transverse channels supported on posts at either side, to which, in turn are fastened angles parallel to the side walls; skids supported on I-beams carry the weight of the chain at the bottom. A pipe, flush with the side wall, and extending nearly the length of the stoker, carries the adjusting rod and takes the tension off the frame. While the take-up in the tension of the chain is at the rear, the actual adjustment is at the front which is always accessible.

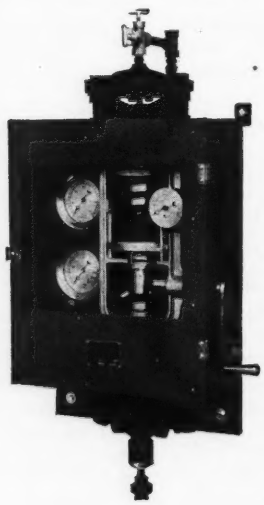
With natural draft, zone control may be applied, if desired, by placing louvre dampers between the channels in one or more compartments. Where conditions make it desirable to change to forced draft, this can readily be accomplished by substituting forced draft links, adding dampers and installing an internal seal and hood at the front.

A water-cooled rear shaft such as is used on the forced draft type is optional with this design.

Swartwout Master Control

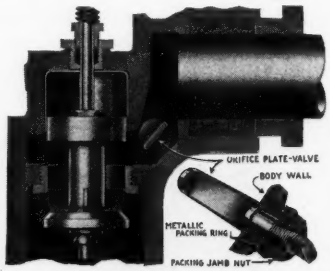
THE SWARTWOUT Type CPQM Master Control was developed by the Swartwout Co., Cleveland, O., for use where accurate steam pressure control is essential and where frequent adjustments are necessary to provide the correct pressure for the various processes.

In operation the Type CPQM Master Control utilizes the principles of Swartwout S-C Master regulators. New features and refinements, however, are offered for the first time in this new master control. The Equipment consists of the pressure regulator to which is attached a small indicating dial, and the two main pressure gages, all enclosed in a sturdy tamperproof case. A removable crank is used in adjusting the pressure. A turn of this crank sets the hand on the small dial to the desired pressure which is automatically set up and accurately maintained.



Pressure Regulator for Bayer Soot Cleaners

THE BAYER Co. of St. Louis, Missouri, has recently placed on the market a new development in soot cleaner operating heads. This new Bayer Balanced Valve-in-Head includes an exclusive feature for regulating the steam pressure, which is essential when boilers operate in the higher steam pressure ranges. These new operating heads incorporate an orifice plate-valve installed across the steam passage from the balanced valve to the cleaner element. This orifice plate-valve may be checked and adjusted in a few minutes to regulate the



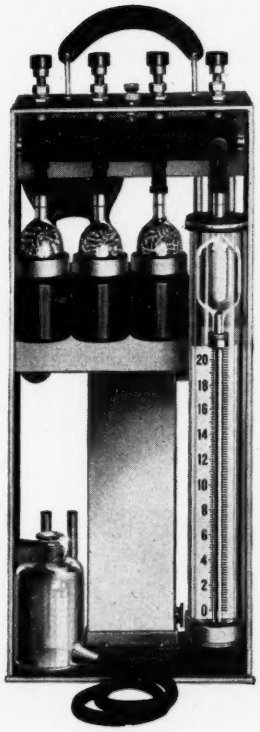
steam pressure at the cleaner nozzles in order to obtain maximum cleaning efficiency with minimum steam consumption. Regulation of the steam pressure in this way at each operating head will reduce steam consumption, the manufacturers claim, from 30 per cent to 50 per cent.

An additional feature in this new Balanced Valve-in-Head is the development of arc limit stops so that where required a complete 360 deg. revolution may be made.

These operating heads are built for all pressures and temperatures with semi-steel or electric cast-steel bodies and all valve parts are made of alloy or stainless steel.

New Features of Ellison Analyzer

MANY IMPROVEMENTS in the details of construction and materials used have been incorporated in the design of the new portable gas analyzer now being marketed by the Ellison Draft Gage Co. of Chicago, Ill. Being designed especially for the analyzing of flue gases, provision is made in the case for carrying a draft gage set and a flue gas thermometer. Accuracy, convenience, freedom from corrosion and elimination of breakage are some of the outstanding characteristics of this design.



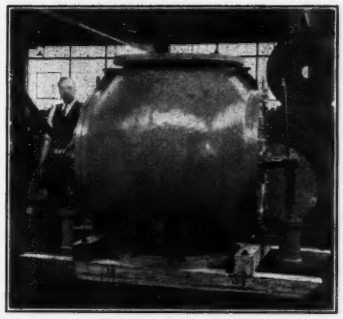
Headers and seats are made of corrosion-proof hard rubber. This has necessitated the design of a new type needle valve which has a swivel joint and requires no grease to keep it leakless. Curled hard rubber is used in the absorption chamber to furnish absorption surface as it is light in weight and will not corrode nor scratch the glass surfaces. The chamber for the acid cuprous chloride solution is provided with copper for reducing the solution to a straw-yellow color. The solution container is of hard rubber, provided with nipples closed with rubber caps.

The burette of glass is surrounded by a glass jacket filled with glycerine which keeps the celluloid scale and all other surfaces inside the jacket clean and prevents damage from freezing. Mercury can be used for the leveling liquid, thus doing away with the aspirating bulb where weight is not objectionable, as for stationary use.

Rust resistant, chromium plated, furniture steel is used in the construction of the case and with all rubber parts black in color, the instrument has an attractive appearance.

Relief Valve

AT THE MUNICIPAL ELECTRIC PLANT, Holyoke, Mass., the surface condenser of the new 5000-kw. turbine is protected by a 36-in. vertical exhaust relief valve which embodies several distinctive features. The turbine will run condensing with about 28.5 in. of vacuum the greater part of the time. When low water supply occurs, the operation will be non-condensing at full load. At such times the disc is held wide open by the counterweights. Full 36-in. pipe area through the seat and body passages give complete relief without back pressure. For warming up the turbine prior to operation, the valve may be opened with the hydraulic lift cylinder.



The Municipal Plant was designed by McClintock & Craig, Springfield, Mass., and the valve, which weighs 7600 lb., was manufactured by Davis Regulator Co., Chicago, Ill.

A.S.R.E. Spring Meeting

AN IDEAL outdoor setting has been selected for the 21 Spring Meeting of the A. S. R. E. to be held June 20-22 at Skytop Lodge, Penna.

At the welcome luncheon on Wednesday, J. I. Lyle will talk on "Trade Association Relations under the N.R.A." Another important feature of the technical program in the joint meeting on Thursday morning with the A.S.H.V.E., which will be in session at the same time at Buck Hill Falls, a nearby resort. At the joint meeting W. H. Carrier, past president of both societies, will preside over a program devoted to the latest air conditioning problems.

An incomplete list of papers to be presented on the technical program follows:

Commercial storage of foods, R. E. King; Systems used in truck bodies, E. R. Ryan; The rural milk problem, John E. Nicholas; The water vapor centrifugal compressor, Paul Bancel; Electric rate making for small air conditioning units, D. W. McLenegan; Noise reduction, E. J. Abbott.

A.S.M.E. Oil Power Meeting

ANNUAL MEETING of the National Oil & Gas Power Section of the American Society of Mechanical Engineers will be held June 20-23 at the Pennsylvania State College, State College, Pa. Five technical sessions have been arranged and the papers will cover all phases of Diesel engineering. Among the titles are: Factors influencing the regularity of jerk-pump injection, Theodore B. Hetzel; Honing of cylinder liners and pump barrels, K. W. Conner; Design of a fuel-injection pump, C. R. Alden; Penetration of oil sprays in dense air, Paul H. Schweitzer; Maintenance Schedule in a Diesel plant, Harry C. Major; The situation concerning Diesel fuel oil, T. B. Rendel; Wear of Piston rings and liners influenced by piston ring design, W. G. G. Godron; Diesel cost report, M. J. Reed and Interpretation of cost report data, L. H. Morrison.

In addition to these papers, a number of symposiums have been arranged covering accessory progress and high speed Diesel engines.

The social program will begin with a dance on Wednesday evening, and includes picnics, mountain excursions, golf tournaments, and on Friday evening a banquet and dance followed by moving pictures of oil country prime movers and driven machines by R. W. Rogers.

J. Asa Palmer

J. ASA PALMER, president and general manager of The Burt Manufacturing Co., Akron, Ohio, died on May 1st. Mr. Palmer was born in Akron, Ohio, July 7, 1868, and was a lifelong resident of that city. After graduation from Buchtel College in 1889 he spent a few years in the West but returned to Akron and became affiliated with Aultman-Miller & Co., with whom he remained until 1903 when he entered the employ of The Burt Manufacturing Co. A year later he was made secretary of the company and in 1921 elected president and general manager, succeeding the late William F. Warden. He held this position up to the time of his death. Mr. Palmer was intimately associated with the iron and steel industry as well as the building and construction industry, through his connection with The Burt Manufacturing Co., and his passing will be felt as a loss to these industries.

News From the Field

H. S. COLBY has just been appointed general sales manager of Combustion Engineering Co. Mr. Colby, until recently, was president of the Air Preheater Corp. His technical education was acquired at Cooper Union and Columbia University and for the past 20 yr. he has been engaged in the design, production and sales of steam generating equipment involving boilers, stokers, pulverizers, economizers and air preheaters.

COMBUSTION ENGINEERING CO., INC., reports the sale of a 410-hp., 425-lb. bent tube boiler with water walls, economizer and forced draft chain grate stoker to the Colgate-Palmolive-Peet Co. The latter company report that this boiler and a new turbo-generator are to be installed at its Jeffersonville, Ind., plant in connection with a modernization and extension of the production facilities of the whole plant. This installation, which includes other equipment for heat balance and steam distribution, is the first step in a long term improvement in the power plant. The new equipment is expected to be in operation in July.

REPLACEMENT of the present steam-driven electric generating plant by Diesel engines at a cost of about $25,000 is planned by the Cheyenne River Indian Agency, Cheyenne Agency, S. Dak. The new generating equipment will consist of one 40 and one 86 kv-a. unit with the necessary switchboard and changes to convert the present d.c. line for a.c. service. The present boiler room will be repaired and maintained for heating service. C. E. Brashear, Federal Bldg., Fargo, N. Dak., is superintendent of construction and E. A. Kuester is chief engineer at the Agency.

STOCK ENGINEERING CO., Cleveland, Ohio, announces that it has taken over the sale of the Conical Non-Segregating Coal Distributor which was developed a number of years ago by Arthur J. Stock and licensed to the Rolland Gardner Co. for manufacture and sale. This license has recently been terminated and the work of manufacturing and selling has been taken over by the Stock Engineering Co.

DEARBORN CHEMICAL CO. announces that George S. Rickenbach will represent the company in the Cleveland territory, taking the place of Emerson Henry Ruhlman whose death occurred on April 14. C. C. Brown will look after the southern part of the territory handled by Mr. Ruhlman.

THE FOSTER WHEELER CORP., New York City, has taken over exclusive rights for the sale and manufacture of the Ruths Steam Storage Systems in the United States and Canada. G. M. Cameron, formerly manager of Ruths Steam Storage Co. will be manager of the Ruths Accumulator Division of Foster Wheeler.

SHEPPARD T. POWELL, Consulting Sanitary and Chemical Engineer, Baltimore, who will deliver the Ninth Edgar Marburg Lecture at the 1934 annual meeting of the American Society for Testing Materials, to be held in Atlantic City, N. J., June 25-29, on the subject "Water as an Engineering and Industrial Material." Mr. Powell, who is an outstanding authority on water and its problems, and well known in the power plant field, will review briefly the uses of water in engineering and industrial projects. He will outline specific requirements in different industries and discuss the advances in the art of water purification. The problem of testing forms a large portion of the lecture, especially analytical procedure. A brief survey of the current research in this country and abroad will focus attention on the potential value of petrographic, spectographic and other applications of analytical procedure.

APPOINTMENT of Albert S. Low as vice-president and chief engineer of the Austin Co., Cleveland, Ohio, has been announced by George A. Bryant, Jr., executive vice-president of the company. Mr. Low succeeds as chief engineer Harry E. Stitt who will continue his association with the company as consulting engineer. He has been with Austin Co. for 21 yr. and has been active in all branches of its work. During the past 12 yr. he has been in charge of the central district as regional vice-president with headquarters at Chicago. Peter C. McCabe who has been associated with the Austin Co. for 14 yr. in various capacities will succeed Mr. Low as acting district manager in charge of the west central district with headquarters at Chicago.

For the Engineer's Library

HANDBOOK OF CHEMISTRY AND PHYSICS. Eighteenth edition. Editor in Chief, Charles D. Hodgman. 1818 pages, size 4½ by 6¾ ins. Flexible Fabrikoid binding, gold edges. Published by Chemical Rubber Publishing Co., Cleveland, Ohio, 1934. Price $6.00.

Even a most casual glance through this astonishing book fills one with a sense of unimportance, of ignorance almost. For before such an amazing and vast accumulation of technical knowledge, even the most brilliant among us suffers sadly by the comparison. The amount of information contained between the covers of this book is incalculable—it represents the concentrated mental and physical efforts of thousands of technicians and investigators over a period that can only be measured in terms of centuries.

It is difficult to review a book like this. Of course, one might present an abstract of the table of contents, which in itself is formidable or we could enumerate the number of pages devoted to various subjects. We could say, for example, that 220 pages are given to mathematical tables and formulæ, 800 pages of chemical tables, 204 pages on light, 135 pages on heat and so on but these are merely statistics and do not reflect the true character of this book. But to thumb through it, to see the hundreds of pages filled with the most diverse chemical and physical data, to run across pages of constants which you have often wished for but could not get, to find data on things in the field you are directly interested in, then and only then can one appreciate the value of this handbook. This, we realize, is high praise but it is deserving. We have seen and valued many handbooks, mechanical, electrical, chemical, many of which to one engaged in any of these respective fields are invaluable, but no handbook covers all of these fields so thoroughly as does this one.

The character of the data is fundamental. It is almost entirely concerned with the presentation of physical, chemical and electrical constants and values. In the 800 pages of chemical tables for example, the physical constants of over 4000 organic and 4000 inorganic and metal organic compounds are listed. These naturally are largely of interest to the chemical engineer, but equally complete data is presented in other fields.

It is because of the strict adherence to fundamental data that this handbook is so generally useful. Every branch of science has its own underlying tables but these in all cases are based upon the fundamental data of physics, chemistry and mathematics. The mathematical material is particularly complete. The usual tables of logarithms and trigonometric functions are included also a table giving the prime factors of all factorable numbers and the logarithms of all prime numbers from 1 to 2000. This table is to be found in relatively few collections of mathematical tables, yet it is very useful. These of course cover only a few of the mathematical tables; there are many others. Another unusual table is an exhaustive list of American and foreign photographic films and plates giving both the Hunter & Driffield as well as the Scheiner speed numbers. As far as we know no table of film speeds published in this country approaches this one in completeness. Regarding the chemical elements, the descriptive matter is unusually complete; all of the radioactive and recently discovered elements are listed; the same applies to isotopes. The section on measures and units covers 134 pages, one of the most complete lists of tables on the subject we have seen. Not only is complete data on the properties of saturated steam presented for pressures up to 336 lb. per sq. in. but there are also tables giving the temperatures of saturated steam up to 3184 lb.

These are mere random items selected to indicate the character of the information. Every branch of science has a major division in the book.

This eighteenth edition has really been some 20 yr. in the making. Constant revision and addition year by year has made perhaps the most useful one volume reference work available and we have no hesitancy in recommending it most highly to all engineers and scientists who have occasion to refer to fundamental data of a scientific nature.

DIESEL ELECTRIC LOCOMOTIVES in 15 standard sizes with specifications, drawings, performance curves, operating data, are included in a new 80 page publication, circular 1994, issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

OIL FIELD WELDING, a special issue of Fusion Facts just published by the Stoody Co., Whittier, Calif., describes the practical application of welding and hard surfacing to the repair of various tools and machinery used in the oil fields.

RESULTS OF MUNICIPAL LIGHT PLANTS, by C. F. Lambert, shows what 363 cities with municipal electric systems pay for electricity. The past year has brought about many drastic rate changes in both private and municipal plants and the book is a record of the rates, earnings, operating expenses, net profits, power production and other information relating to electricity. The book may be procured at the cost of $1.00 by addressing the publishers, Burns & McDonnell Engineering Co., 107 W. Linwood Blvd., Kansas City, Mo.

OIL BURNER HEATING. Published by Domestic Engineering Publications, 1900 Prairie Ave., Chicago, Ill. Size 5½ by 8 in., 169 pages, cloth bound. Price $1.00.

A practical book on the subject of selling and making domestic oil burner installations. Charts and tables are included to make it possible to figure quickly and easily the cost of heating with oil. A considerable portion of the book is given over to the discussion of special piping layouts, modern trend toward recreation rooms in basements. Combustion chambers, conversion of gas fired boilers and other engineering data for the practical man are included.

THE NIAGARA COMBUSTION CORP., Niagara Falls, N. Y., has just issued a catalog describing the Niagara Overfeed Sprinkler Stoker, giving in some detail the features of design and construction and results from reports from users of the stoker who are burning low priced fuels.

DIRECT-CURRENT MOTORS is the subject of two new Wagner looseleaf bulletin sheets, known as "Bulletin 167, Part 8." It is profusely illustrated, and all motor design and construction details are fully described.

AMERICAN DISTRICT STEAM CO., North Tonawanda, N. Y., has just issued a folder describing construction details and uses to which the Adsco storage type water heaters are put. This folder is designated No. 133.

DEARBORN CHEMICAL CO., Chicago, Ill., is distributing a new circular describing the use of Dearborn Tannin Brick No. 2 in cooling systems for Diesel and gas engines, compressors, condensers and open and closed systems of all types for the prevention of scale, corrosion and algae growth.

WHITING CORP., Harvey, Ill., is distributing copies of its new house organ, Crane Engineering Illustrated, the purpose of which is to supply useful information on the application of traveling cranes to industrial work of various kinds.

REPUBLIC STEEL CORP., Massillon, Ohio, has just published a 16-page brochure containing data on Enduro 18-8 Stainless Steel as well as several of the more important variations which make up the Enduro 18-8 series of types. One feature of the booklet is a table of laboratory corrosion data listing the degree of corrosion resistance of several alloys to chemical solutions and products under varying conditions of temperature and concentration.

THE LUNKENHEIMER CO., Cincinnati, Ohio, has just published a booklet describing the Lunkenheimer plug type Ferrenewo and Renewo valves which are used for severe throttling service. The illustrations are in color, clearly indicating the material of which they are made and the booklet gives tables of sizes and prices, dimensions and construction features.

THE JAMES LEFFEL & CO., Springfield, O., has issued under the title, "Leffel Turbine Water Wheels" its bulletin No. 32, which consists principally of halftone illustrations of wash drawings showing the cross-sections of many hydraulic turbine plants which have been installed by this company.

BACHARACH INDUSTRIAL INSTRUMENT CO., Pittsburgh, Pa., under the title, "Measurement of Shaft Horsepower" has prepared bulletin No. 270, describing its new torsion instrument known as the Maihak Torsionmeter, which has its greatest field of application in the determination of power transmitted through propeller shafts and in testing the efficiency of machine tools and gear transmissions.

THE RIDGE TOOL CO., Elyria, Ohio, is distributing literature on a new poster threader that has many improvements over similar products in its class. Among the improvements are direct drive, full floating posts, enclosed chaser locks, new rachet control, 2-in-one threader, new type workholder and interchangeable chasers.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., has just issued Folder 85-10 illustrating the importance of automatic temperature control and describing the important features of Brown automatic temperature controllers.

THE HAYS CORPORATION, Michigan City, Ind., announces in its bulletin a new product known as the Hays Portable Gas Calorimeter for determining the heat value of gas, amount of combustibles unburned in whole gases, explosive limits of gases, explosive properties of sewage and mine gases, heating value of gaseous mixtures, and correct setting for gas burners.

POOLE FOUNDRY & MACHINE CO., Baltimore, Md., describes in a recent circular improvements which have been incorporated in the Poole flexible couplings.

DETERMINATION of the Economic Lot Sizes in Manufacturing Industries is the title of Engineering Extension Division Series, Bulletin No. 31, published by the Virginia Polytechnic Institute, Blacksburg, Va. The bulletin written by Professor Paul T. Norton, Jr., presents the development of a formula which, taking into account direct manufacturing costs, overhead, desired return on the investment, taxes, storage costs, etc., determines the size and most economic quantity of the given product for the manufacturer to produce at one time in order to give the lowest overall cost.

BAILEY METER CO., Cleveland, Ohio, is distributing to engineers and executives responsible for the economical generation of steam in municipal, institutional and industrial power plants a new 32-page bulletin, "Savings Effected by Bailey Boiler Meters." This bulletin includes actual operating data showing the nature and amount of savings effected in over 20 typical installations of Bailey boiler meters which cover a wide range of fuels, methods of firing, types and sizes of boilers.

LINK-BELT CO., Chicago, Ill., has just published an interesting book, "Firing Method Modernized For Profit," giving a comparison of hand firing and controlled automatic underfeed firing of boilers from 10 to 250 b.hp. This book illustrates in graphic and pictorial form such features as smoke elimination, uniform temperatures and pressures, coal savings, firing efficiency, etc., etc.

FRICK CO., Waynesboro, Pa., is distributing a new bulletin designated as No. 153-C on their Instant Water Coolers which are thoroughly described and illustrated in the bulletin.

CONSTRUCTION and design details of Diesel engines built by the Buckeye Machine Co., Lima, Ohio, are given in an illustrated catalog published as Bulletin No. 605.

FLOW OF PAPER PULPS in pipe lines is the title of a bulletin issued by the University of Maine, Orono, Me., as Maine Technology Experiment Station Paper No. 2. The booklet gives the result of tests made by C. A. Brautlecht and J. R. Sethi on friction due to pumping paper pulps in various lengths of pipe; 17 tests were made on variation and concentration of suspension, length of pipe line and introduction of fittings.

STERLING ELECTRIC MOTORS, INC., Los Angeles, Calif., describes in its bulletin No. 133 a new Upright Enclosed design of Sterling Vari-Speed motors. These motors, which give an infinite speed variation for industrial purposes, are now built in both horizontal and vertical types.

DIAMOND POWER SPECIALTY CO., Detroit, Mich., has recently issued two interesting bulletins, one entitled The Diamond Bi-Color Water Gauge and Illuminator; the other entitled Water Level Detector. These bulletins describe new equipment recently placed on the market by this company.

JOHNS-MANVILLE, New York, N. Y., is distributing a brochure on Johns-Manville transit pressure pipe containing installation illustrations for the most part from municipal water works. Considerable useful information is also given on the features of installation, capacities and pressure losses in piping systems of this character.

COMMONWEALTH ELECTRIC & MANUFACTURING CO., Boston, Mass., in its bulletin No. 52A describes electric-heated miniature steam generators used for industrial purposes in capacities ranging from 2 to 18 kw., and suitable for pressures up to 300 lb. ga. This new line of boilers is thought to be applicable to many plants using a small amount of steam in the summer time, thus enabling the shutting down of big main heating boilers for the summer season.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., in its catalog No. 9001 features Brown resistance thermometers for temperatures from minus 300 to plus 1000 deg. F. and describes recent improvements in these instruments, consisting of such features as the universal case, electric chart drive, combination door handle and lock, and toggle switch for chart drive.

FULTON SYLPHON CO., Knoxville, Tenn., is distributing its bulletin No. 225 describing pressure regulators and vacuum regulators which incorporate Sylphon bellows in their design. The bulletin contains considerable descriptive material and installation instructions valuable to the power plant engineer.

Power Plant Construction News

Ark., Yellville—General Mining Corporation, Yellville, recently organized, J. H. Hand, vice-president and general manager, plans installation of electric power equipment in connection with development of zinc and lead properties near Yellville, including construction of new mill for refining service. Entire project will cost over $80,000.

Calif., Benicia—Lloyd G. Ham, Benicia, Calif., care of Hunt, Mirk & Co., 141 Second Street, San Francisco, architects and engineers, plans installation of electric power equipment in proposed new distilling plant at Benicia. A one-story power house will be built. Entire project is reported to cost close to $75,000. Engineer noted will be in charge.

Calif., Los Angeles—Western Blind & Screen Co., 2700 Long Beach Avenue, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire. Loss estimated over $65,000.

Calif., San Francisco — Wieland Brewery, 240 Second Street, plans installation of power equipment in connection with expansion and improvement program, entire project estimated to cost about $125,000. Herman Noethit, address noted, is engineer, in charge.

Conn., Bridgeport—Ebling Brewing Co., 937 Fulton Street, Brooklyn, N. Y., plans installation of electric power equipment, refrigerating machinery and other mechanical equipment in connection with an expansion and improvement program at branch brewery on State Street, Bridgeport. Entire project reported to cost close to $50,000.

Ind., Lawrenceburg — James Walsh & Co., Lawrenceburg, plans installation of electric power equipment in new multi-story distilling plant on local site. Entire project reported to cost about $350,000. Hillsmith & Co., 108 East Third Street, Dayton, Ohio, are engineers and contractors.

Ind., Terre Haute—Merchants Distilling Co., plans new one-story power house in connection with an expansion and modernization program at distillery. Also, will install electric power equipment in main distillery. Entire project is reported to cost close to $60,000. Walter C. Wagner, Breslin Building, Louisville, Ky., is architect and engineer.

Kan., Kansas City — Fowler-Straub Packing Co., 100 Meyers Street, plans installation of power equipment in new two-story addition to meat packing plant. Entire project reported to cost about $28,000. O. J. Barth, National Fidelity Life Building, is engineer.

Kan., Strong City—City Council is concluding arrangements for financing for $53,000 for new municipal electric light and power plant, using Diesel engine-generator units. E. T. Archer & Co., New England Building, Kansas City, Mo., are consulting engineers.

Kan., Wichita — All-Steel Products Co., 805 South Wichita Street, is said to be planning installation of motors and other power equipment in new one-story addition, 60 x 120 ft., on which work will soon be placed under way.

La., New Orleans — Pan-American Distilling Corporation, care of Irving R. Saal, vice-president, Jackson Brewing Co., Wilkinson and Decatur Streets, plans installation of electric power equipment in proposed new local distillery. Company was recently organized, and is arranging for sale of stock in amount of $403,000, portion of proceeds to be used for purpose noted.

Mich., Detroit—Ekhardt & Becker Brewing Co., Orleans and Winder Streets, plans installation of electric power equipment in new six-story and basement plant addition. Entire project reported to cost over $100,000. Paul Tilds, 2539 Woodward Avenue, city, is architect.

Mich., Kalamazoo — City Council, City Hall, is considering installation of new street-lighting system to cost about $50,000. City engineering department will be in charge.

Minn., Benson — City Council plans call for bids early in June for extensions and improvements in municipal electric light and power plant, including new 350-hp. boiler unit, superheaters, stoker, etc. A fund of $50,000 has been arranged for program. Burlingame & Hitchcock, Sexton Building, Minneapolis, Minn., are consulting engineers.

N. J., Lyndhurst — United Cork Co. plans installation of electric power equipment in connection with rebuilding of portion of plant, recently destroyed by fire. Loss over $100,000, including equipment.

N. Y., Buffalo—Department of Public Works, City Hall, George J. Summers, public works commissioner, is considering construction of a municipal electric light and power plant at city waterworks for street-lighting and public buildings, including transmission lines and distributing system. Estimated cost about $500,000.

N. Y., Brooklyn—Preferred Oil Co., Inc., 95 First Street, plans installation of tanks, pumping machinery and auxiliary equipment for new bulk oil storage and distributing plant on East River waterfront, with initial capacity of about 3,000,000 gals. Cost over $85,000 with equipment. Samuel Kobre is president.

N. Y., Newark—State Department of Mental Hygiene, State Office Building, plans one-story power plant at institution at Newark, where several other buildings will also be erected. State Department of Architecture, address noted, in charge.

N. Y., Syracuse — M. J. Vincent & Sons Coal Co., 115 East Genesee Street, plans new coal storage and distributing plant with conveying, elevating, loading and other mechanical equipment. Entire project is reported to cost about $35,000.

Ohio, Cleveland — Steel & Tubes, Inc., 224 East 131st Street, plans installation of electric power equipment in proposed new two-story addition, 80 x 640 ft., entire project reported to cost over $150,000.

Ohio, Columbus — Board of Public Works, City Hall, is having revised plans drawn for extensions and improvements in municipal electric light and power plant, estimated to cost approximately $1,000,000. New generator unit, condenser and auxiliary equipment, will be installed, as well as two watertube boilers, pumping units and accessories. Engineering department is in charge.

Ohio, Green Springs—Green Springs Mineral Water Crystals, Inc., Freemont, Ohio, S. Wolf, president, plans installation of power equipment in proposed new plant at properties at Green Springs. Entire project will cost over $30,000.

Ont., Leamington—H. J. Heinz Co., Ltd., 1062 Progress Street, North Side, Pittsburgh, Pa., plans installation of electric power equipment in new addition to food product canning plant at Leamington, entire project to cost over $1,000,000.

Pa., Northampton — Northampton Brewery Corporation plans installation of electric power equipment in connection with expansion and improvement program for increased capacity. Company is arranging financing for about $461,000, portion of fund to be used for purpose noted.

Pa., Philadelphia — Container Corporation of America, Inc., Nixon and Fountain Streets, plans one-story addition to power plant, with installation of new equipment, including 5000-kw. turbo-generating unit and accessories. H. M. Wilson Co., Eighteenth and Brandywine Streets, city, is engineer.

Pa., Pittsburgh—Westinghouse Electric & Mfg. Co., East Pittsburgh, has approved plans for initial unit of new steam power house for plant process and heating service, estimated to cost about $400,000, with equipment. Additional units will be added at later date, with ultimate cost close to $1,000,000.

Texas, Corpus Christi—Corpus Christi Refining Co., identified with Taylor Refining Co., Taylor, Texas, and Alamo Refining Co., Willow Springs, Texas, plans installation of power equipment, including air compressors, pumps, boilers and accessories, for new gasoline refining plant on site near city. Entire project will cost about $100,000. J. F. Whitehurst is general manager.

Texas, Raymondville—Board of Directors, Willacy County Water Control and Improvement District, No. 1, Raymondville, plans installation of a series of pumping plants in connection with irrigation project. A fund of $4,853,000 has been secured through Federal aid for entire project. Bids will soon be asked. Morgan Engineering Co., Harlingen, Texas, is consulting engineer.

Utah, Garfield — American Smelting & Refining Co., 120 Broadway, New York, N. Y., plans installation of electric power equipment in connection with expansion and improvement program at smelting plant at Garfield. Entire project will cost close to $150,000.

Wash., Spokane—Spokane Brewing & Malting Co., 901 Broadway, plans installation of electric power equipment in new multi-story addition. Entire project reported to cost over $50,000.

Wis., Eau Claire—Wisconsin Steam Corporation, Eau Claire, care of Buell & Winter Engineering Co., Insurance Exchange Building, Sioux City, Iowa, consulting engineer, has preliminary plans under way for new one-story central steam power plant, estimated to cost close to $100,000. Engineering company noted is in charge.